SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY 1913.

GENERAL PHYSICS.

142. *Bessel's Measuring Apparatus.* **P. Thomas.** (Kaiserl. Normal-Eichungs Kommission, Wiss. Abhandl. No. 8. pp. 113–148, 1912.)—Research during the years 1908, 1909, and 1910 with Bessel's apparatus has led to the following results :—(1) The readings of the metal thermometer do not bear unique relations with the observed temperatures, as has usually been supposed up to the present, but are dependent also on previous temperature variations. (2) The measurements carried out in 1880 with Bessel's apparatus gave results somewhat too large in consequence of the effect of thermal after-action. (3) Several variations of length of the different rods used were noted between 1908 and 1910, contractions being observed of from 0·01 to 0·06 mm. A. W.

143. *Large Comparator.* **W. Kösters.** (Kaiserl. Normal-Eichungs Kommission, Wiss. Abhandl. No. 8. pp. 87–109, 1912.)—Describes at length, with numerous illustrations, the construction and use of the large comparator used by the above Commission. A. W.

144. *A Standard Measuring Machine.* **P. E. Shaw.** (Roy. Soc., Proc. Ser. A. 87. pp. 385–390, Oct. 31, 1912.)—Gives an outline of the scope of an improved type of machine constructed by the author on the principle of electric touch [Abstract No. 1116 (1906)] and now installed at the National Physical Laboratory. Details and tables of results are to be given later.
L. H. W.

145. *Ruler for Drawing Curves.* **Berkeley.** (Phil. Mag. 24. pp. 664–668, Oct., 1912.)—Describes an adjustable form of steel ruler, which may be bent so as to pass through a number of points. Two metal T-squares each carry two slotted pegs, one on either arm of the head, and these pegs can be placed at any point along their respective arms. Through the slots in these pegs passes a long flexible steel ruler, which, in the apparatus described, was 1·5 m. long, 5·7 cm. wide, and 2·4 mm. thick. The long arms of the T-squares each carry a projecting peg, adjustable in position along the arm, and round these pegs a cord passes, provided with an arrangement for shortening or lengthening as desired. By varying the relative positions of the various pegs and by altering the tension on the cord, the ruler can, within fairly wide limits, be made practically to coincide with any simple curve. If the curvature change sign the ruler cannot in general be made to follow the curve; but if the inflection be near the end of the curve, adjustment is possible if on the long arm of one of the squares the peg carrying the cord is brought near the head, while at the same time that on the other square is some distance from the head, so that the line joining these pegs passes between the two pegs on the head of the first T-square. A. W.

146. *Length Standard and Thermal Expansion of Copper.* **G. F. K. Langbein.** (Kaiserl. Normal-Eichungs Kommission, Wiss. Abhandl. No. 8. pp. 151–167, 1912.)—Describes the elaborate series of tests of the principal length standard of the Commission, and the determination of the thermal expansion. A. W.

147. *Elastic Peculiarities of Platinum-Iridium Wires.* **L. P. Sieg.** (Phys. Rev. 35. pp. 347–358, Nov., 1912.)—Further investigation of the elastic properties of Pt-Ir wires shows that in spite of a peculiar variation of period with amplitude and of an enormous change in the decrement of these wires as they die down in their vibrations, they obey Hooke's law both statically and kinetically, and their torsional vibration is practically angular harmonic. The elastic properties vary with the period of vibration, and are profoundly modified by long-continued rest under load, and by drawing the wires. It is concluded that these phenomena are related to the crystalline structure of the alloys, which appears to be exceptionally sensitive to such treatment as annealing and drawing. [See also Abstract No. 10 (1911).] W. H. Si.

148. *Elastic Strength of Flat Plates.* **W. J. Crawford.** (Roy. Soc. Edinburgh, Proc. 32. pp. 348–389, 1911–1912.)—Owing to the abstruse mathematics involved in the general case of a thin isotropic plate, exact elastic equations have been obtained only for circular and elliptical plates. Grashof has, however, obtained approximate relations for square and rectangular plates. In the present work, planished steel plates were clamped between duplicate forming-blocks of the desired shape and subjected to oil pressure. The condition was thus obtained of a uniformly loaded plate clamped at the edges. Deflections were read by a micrometer screw-gauge with reference to a bar fixed relative to the base of the apparatus. A Starret dial test indicator and an optical indicator were also used, but the micrometer was found to be the most convenient and accurate. A zero error was evident in all cases, being due to small initial irregularities in the plates and to minute yielding at the fixed edges. A typical pressure-deflection curve consists of an initial curved portion, showing instability in the plate, followed by the straight elastic line, from which the theory is tested. Finally, at a load of from 2 to 6 times that which causes the first permanent set, the line again curves, showing increased resistance to bending as the plate assumes an arched form. It was concluded that measurement of central no-load deflections after application of pressure gives a most delicate indication of the exact pressure for initial failure, no matter where it occurs; for the plate is in the position of an encastré beam, so that yielding at the ends or any other part produces a maximum set at the centre. The results obtained for circular plates confirm very closely the value $f_3 = (2/3)(r^2/t^2)p$, where $f_3 =$ max.

elastic stress on theory of max. principal strain, r and t are radius and thickness of plate, $p =$ pressure in lbs. per sq. in. for initial permanent set. This formula assumes a value of 3 for Poisson's ratio and has to be corrected for the experimental value, 3·19, for the material tested. The results show clearly that the mathematical analysis is correct and that the max. principal strain is the criterion of failure. It is difficult to detect the pressure for initial failure in square and rectangular plates since all the circumferential fibres do not fail simultaneously, as with the circle. The central deflection readings confirm Grashof's formula for a square plate $v = (1/64)(pb^4/\mathrm{E}t_3)$. A graphic analysis of curvature is made for the square and rectangular plates by plotting deflections, y_1 against distances, x_1 along the diameters and several lines lying between, for a steady pressure. By differentiating twice graphically the stress $f_1 = (t/2)\mathrm{E}\,.\,d^2y/dx^2$ can be mapped over the plate. Grashof gives a value $f_2 = (2b^4/a^4 + b^4)(a^2/t^2)p$ as equivalent to the greatest stress at the ends of a long diam. $2a_1$ with a symmetrical form for the short diam. $2b$. In nearly every case the experimental value $(t/2)\mathrm{E}\,.\,d^2y/dx^2$ is greater than Grashof's, a suggested safe factor for design being 1·25. Ribs for stiffening should be placed parallel to the edges, not diagonally, and should be stouter at the ends than at the centre. **C. G. Knott.** (Ibid. 32. pp. 390–392, 1911–1912.) Crawford's results are in good agreement with Ritz's solution for the deflection of any point in a clamped rectangular plate under uniform pressure, the figures being carried to a third approximation.

E. J. S.

149. *The Circular Diagram of Stress and its Application to the Theory of Internal Friction.* **O. H. Basquin.** (West. Soc. Engin., Journ. 17. pp. 815–847 ; Discussion, pp. 847–849, Nov., 1912.)—In the first part of the paper the general case of the stress at a point in a homogeneous body is investigated following the lines of Mohr's classic work. In most discussions of the two-dimensional case, when the ellipsoid of stress degenerates into an ellipse, it is assumed that one principal stress is zero. The author points out that this is unnecessary if stresses only, without their attendant strains, are considered, for one principal stress has no effect on planes parallel to its own direction. For this case if p_x and p_y are principal stresses at a point in a plane inclined at an angle θ to p_y, p and q being the nominal and shear stresses at the point, then—

$$p = (p_y + p_x)/2 + (p_y - p_x)/2\,.\,\cos 2\theta$$

and—

$$q = (p_y - p_x)/2\,.\,\sin 2\theta.$$

This is shown graphically by setting out p_x and p_y along the axis of abscissæ and describing a circle on $p_y - p_x$ as diam. The co-ordinates of the end of a chord drawn from the end of p_x at angle θ to the axis are respectively the normal and shear stresses on the plane θ. The circle diagrams for a number of problems are described. If a point be taken on the axis of ordinates at height $k_4 =$ the pure shear strength of the material and a line be drawn through this point inclined at the angle of internal friction, ϕ, then the ordinate q corresponding to any abscissa p is $k_4 + p \tan \phi$. This is the value assumed by Navier to be given to the shear strength under a normal stress p by the influence of internal friction, and the line described is called the line of slip. The circle diagram corresponding to any set of stresses which causes failure must be tangent to the line of slip. The increase of compressive strength due to friction is confirmed in practice for brittle materials,

If the theory holds for ductile materials the compressive yield should be 70 % more than the tensile but this is not confirmed. The discrepancy is attributed to unavoidable eccentricity of load. The case of combined stresses is discussed, and compared with Robertson and Cook's results for thick cylinders under pressure. The internal friction theory agrees closely with the experimental data. Rankine's theory of earth pressure is discussed graphically. An experiment is described in which sand in a horizontal cylinder is compressed by a ram till the lateral stress due to the principal stress applied just raises a weight closing a hole in the cylinder. By varying the weight a number of circle diagrams are obtained for the pairs of principal stresses which are all approximately tangential to the line of slip at an angle equal to that of repose of the sand if it is of great depth. The circle diagram illustrates the fact that, for small depths, the angle of repose becomes greater than the friction angle owing to cohesion. Finally the case of a pile is considered, and it is shown that in order to obtain the largest value for the minimum load, a tapered pile should be driven with its large end downward.
E. J. S.

150. *Hardness.* **Hanriot.** (Comptes Rendus, 155. pp. 713–716, Oct. 14, 1912.)—In the Brinell hardness test, the use of small balls under low loads gives lower values than the use of larger balls under correspondingly greater loads. The results of a number of tests on various metals and alloys indicate that this is due to the increased hardening effect of the larger ball and high load. As a result the hardnesses of annealed metals are always found too high. Another source of error lies in the fact that owing to the elasticity of the metal, the impression becomes smaller when the pressure is removed.
F. C. A. H. L.

151. *Mechanical Hardening.* **Hanriot.** (Comptes Rendus, 155. pp. 828–831, Oct. 28, 1912.)—Cold working affects not only the elastic limit but the whole of the mechanical properties of a metal. Some metals are in a state similar to that of the cold-worked, after electro-deposition. The author regards annealing as the inverse of cold working, and regards a metal as cold-worked or mechanically hard when annealing alters its physical properties without changing its chemical composition. As a measure of mechanical hardness the ratio of the ball hardness in the unannealed to that in the annealed state is proposed. It is shown that ball hardness gives a better indication of mechanical hardness than does tensile strength and elongation. By means of a 3-mm. ball under a load of 30 kg. the author has been able to determine the hardness of brittle metals like Bi and Sb. While Bi is very little harder than Pb, Sb gives a very high value. F. C. A. H. L.

152. *The Solidification of Metals from the Liquid State.* **G. T. Beilby.** (Inst. of Metals, Journ. 8. pp. 186–191, 1912. Engineering, 94. p. 427, Sept. 27, 1912.)—The author indicates briefly the lines on which it is intended to work. The problem for solution proposed by the committee appointed by the Council of the Institute of Metals is: "Does molecular aggregation occur in liquid metals immediately before solidification either by the formation of liquid crystalline units or by the segregation of globules enclosed in foam cells?" Quincke holds the view that a foam-cell structure precedes, and persists after, solidification. The author has already shown that solidified gold globules consist of sac-like grains which retain their individuality even after deformation. Annealing of strained metals brings

about a recrystallisation of quite a different type, and it is proposed to distinguish the two types of crystallisation as "primary" and "secondary." It is mainly crystals of the primary type which are affected by the foam-cell formation, but the question arises: "Are the cells formed while the metal is still liquid or in the final stage of crystallisation and, if in the former, are the initial stages brought about by liquid segregation and surface tension or by the crystalline aggregation of molecules in the liquid state?" Watched under the microscope, crystallisation in thin films appears to start from isolated nuclei and to proceed radially. Under high magnification it appears that the radii from adjoining nuclei stop short before they actually meet, so that when solidification is complete it appears as if a network had been spread over the surface. There can be no doubt that the resulting cell-like structure is entirely controlled by the nuclei, and has no relationship with any foam-cell structure which may have previously existed in the liquid. While this does not negative Quincke's hypothesis, it removes the necessity for its postulation; but it is hoped that the inquiry will have a greater scope than the proof or disproof of the foam-cell theory. F. C. A. H. L.

153. *The Effect of Temperature on Tensile Tests of Metals.* **A. K. Huntington.** (Inst. of Metals, Journ. 8. pp. 126–144; Discussion, pp. 145–148, 1912. Engineering, 94. pp. 437–439, Sept. 27, 1912. Mech. Eng. 30. pp. 465–469, Oct. 11, 1912.)—Various results are given showing the effect of temperatures higher than atmospheric on tensile tests of copper and its alloys and comparing these with wrought iron and steel. The tests were made with a horizontal machine of the Kirkcaldy type, and the test bars were of two patterns: one for use with high-temperature thermometers, and the other for use with thermo-electric couples. Details are given of the method used in carrying out the tests, also tables of results for electrolytic copper, arsenical copper, copper-tin alloy, copper-nickel, copper-aluminium, copper-zinc, mild steel, and wrought iron. On taking the electrolytic copper as a standard of comparison and comparing with it the copper alloys, it is seen that, broadly speaking, they have the same characteristics. The curves obtained for the yield-points approximate to straight lines, except in the case of copper-zinc, and the breaking-load curves closely approximate to straight lines, but show signs of being influenced by the second metal at the higher temperatures. The most distinctive curves are those for elongation and reduction of area, which show the preponderating influence of the copper and the modifying effect of the added metal. Considerable differences are shown in the various curves given for mild steel and wrought iron when compared with the others; in the yield-point curves, the only resemblance to iron and steel is found in the copper-zinc alloy. C. O. B.

154. *Testing with a Freely Falling Ball.* **J. J. Schneider.** (Rev. de Métallurgie, 9. pp. 569–577, Oct., 1912.)—There can be no doubt that hardness measured by shock is different from that measured by means of a gradual pressure. Using an apparatus which consists essentially of a ball allowed to fall freely by means of a sort of iris diaphragm, the author has investigated the variation of the diam. of the impression with the work done; the variation of the diam. of impression with the diam. of the ball; and the increase of dynamic hardness after the rebound. The paper is too detailed for a short abstract, and should be consulted for further information. F. C. A. H. L.

155. *Universal Testing Machine.* **M. Kurrein.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1943–1946, Nov. 30, 1912.)—Describes a 30-ton testing machine for tension, compression, bending, torsion, and shear experiments. The transforming from one kind of experiment to another occupies only 4 minutes, and accessibility is an important feature. Six illustrations are given. H. S. R.

156. *Calculation of Stress-distribution in Cylindrical Vessels with Variable Cross-section.* **T. Pöschl.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1135–1160, June, 1912.)—Mathematical.

157. *Theory of Taper Columns.* **W. M. Wallace.** (Engineering, 94. pp. 831–832, Dec. 20, 1912. From the Journ. of the Assoc. of Teachers in Technical Institutions.)

158. *Novel Illustrations of Gyrostatic Action.* **J. G. Gray.** (Roy. Soc. Edinburgh, Proc. 32. pp. 406–415, 1911–1912.)—The author describes, with illustrations, some new forms of gyroscopic apparatus which he has devised. These comprise: a stilt top, a gyrostatic bicycle-rider, and two forms of acrobatic top. The gyro wheels are in all cases brought up to speed by being pressed against a leather disc on the spindle of an electric motor. L. H. W.

159. *Motion of Sphere in Viscous Liquid.* **U. Cisotti.** (Comptes Rendus, 155. pp. 641–644, Oct. 7, 1912.)—Deals on the method of energetics with the uniform motion of a sphere in an extended viscous liquid. On the assumption of no slipping at the surface of the sphere, the classic formula of Stokes is obtained. The case of a dry surface is then dealt with by aid of Rayleigh's dissipation function. The paper concludes with reference to certain limiting cases, and compares the resistances to that in Stokes' formula. E. H. B.

160. *Propagation of the Explosive Wave in Solids.* **J. Taffanel** and **H. Dautriche.** (Comptes Rendus, 155. pp. 1221–1224, Dec. 9, 1912.)—The authors discuss the propagation of the explosive wave in solids. They limit the case to cylindrical propagation, and have assumed, as experience seems to justify, that the permanent state is attained. In rectilinear propagation they get from physical principles four equations to determine the five unknown quantities. There are, therefore, an infinite number of types of waves which satisfy these conditions. Assuming that the required wave has a maximum velocity a solution is obtained. They point out that since the velocity of detonation can be measured experimentally to a high degree of accuracy, it is possible to obtain in this way important information about the other variables. A. R.

161. *The Ether.* **D. L. Webster.** (Amer. Acad., Proc. 48. 12. pp. 511–527, Nov., 1912.)—A treatment, largely mathematical, of the existence and properties of the ether. The ether (or electromagnetic) equations, including gravitation and relativity principle, are reduced to five: a pair for the electric field, a pair for the magnetic field, and one expressing Hamilton's principle. As to the structure of the ether it is concluded that, *if granular,* the structure must be exceedingly minute compared to the dimensions of the electrons. The idea is put forward that the ether may be a medium in which there are two similar, but slightly different, interlacing granular structures, whose grains and distances apart are inconceivably small,

even compared to electrons. As to fluidity or solidity, the author concludes that the ether is "solid" in the sense that every particle is permanently connected to the particles near it by connections that cannot be deformed indefinitely, or even by a finite amount without affecting the subsequent motion. A model of the ether, consisting of two interlacing cubical meshes and knots, is then described. F. H. B.

162. *The Dense Haze of June* 10-11, 1912. **H. H. Kimball.** (Mount Weather Observatory, Bull. 5. 3. pp. 161–165, 1912.)—On the 8th and 9th of June the atmosphere at Mount Weather was unusually clear, but by the 10th the upper layers were filled with a white veil of haze. On the 11th this dense haze persisted above, while the lower layers were becoming less clear. On the 12th the haze had become light in the upper atmosphere, but was dense below. A strong odour of smoke was noticeable. Observations on the radiation received at the earth's surface and on the polarisation of sky light during the period are recorded. It is concluded that the upper limit of the haze was at 8 km. height. The weather at the time was anticyclonic, and the suggestion is put forward that the haze consisted of dust particles carried up by convection currents in the still air. J. S. Di.

163. *Influence of Clouds on the Distribution of Solar Radiation.* **H. H. Kimball** and **E. R. Miller.** (Mount Weather Observatory, Bull. 5. 3. pp. 166–172, 1912.)—The paper gives an account of certain cases in which the presence of clouds in the sky increased the radiation recorded by a Callendar pyrheliometer. A typical case was afforded on Feb. 5th, 1912, at Madison, where at 11.40 a.m. a bright sheet of alto-stratus advanced from the north-west. The recorded radiation rose as the clouds approached the sun to a maximum of 1·11 gm. cals. per cm.^{2} per min. when the edge of the cloud reached the sun, and then fell off rapidly. The record from Feb. 3rd, a perfectly clear day, afforded a good comparison, and from this it is deduced that the presence of the cloud sheet increased the radiation 41% above what would have been its value with a clear sky. Several other examples are quoted in which the increase varied from 8 to 20%. With thin sheets of cloud of the alto-stratus type the effect is ascribed to radiation transmitted through the cloud by refraction and reflection, while with heavy cumulus clouds reflection off the surface is regarded as the cause.

J. S. Di.

164. *Solar Radiation Intensities at Madison, Wisconsin.* **H. H Kimball** and **E. R. Miller.** (Mount Weather Observatory, Bull. 5. 3. pp. 173–183, 1912.)—The instrument employed at Madison was a Marvin pyrheliometer, the exposure and standardisation of which are discussed in considerable detail. The observations are compared with those made at Washington, and it is found that while the differences between the intensities at the two stations are unimportant for the warm months of the year, the radiation at Madison shows a pronounced excess over that at Washington for the cold months. After reviewing various causes which might be productive of this result the authors reach the conclusion that in winter, when the northern parts of the United States are generally covered with snow, the atmosphere at Madison contains much less dust than that at Washington. J. S. Di.

165. *Climate of British Columbia.* (Bureau of Provincial Information, Victoria, B.C., Bull. No. 27. [82 pp.] 1912.)—Gives tables of rainfall, snowfall, and temperature; altitudes of places, lakes, and mountains. L. H. W.

LIGHT.

166. *A Chromoscope.* **L. Arons.** (Ann. d. Physik, 39. 3. pp. 545–568, Oct. 15, 1912.)—In the finished instrument [see Abstract No. 41 (1911)], any colour can be determined in terms of the colours obtained from the standard quartz plates by means of a Lummer-Brodhun photometer head. The brightness of the colour is indicated by the circle-scale readings of two Nicol prisms. Thus in the newer instrument four numbers are required to designate the colour under test as to tone, saturation and brightness. The quartz plates are in two systems, but a wide range of colour measurement can be made using one system only. It is considered by the author as one of the greatest advantages of the use of the chromoscope that a colour can be reproduced at any time from its four characteristic numbers alone. In an appendix, the determinations of a number of optical colour-filters by means of the chromoscope are given. G. E. A.

167. *New Reflection Ocular.* **P. G. Nutting.** (Washington Acad. Sci., Journ. 2. pp. 404–406, Oct. 4, 1912.)—In the ordinary Gauss reflection ocular, as used with a refracting telescope, rays from a lamp pass through a side orifice in the tube, and fall upon an unsilvered glass plate set at 45° to the optical axis. The beam thus reflected towards the objective illuminates the cross-threads directly, while the field is illuminated by means of light reflected back from the objective. In the course of the instrumental adjustments for which the ocular is employed, it is necessary to bring the bright cross-threads into coincidence with their dark reflected image [reflected from a mirror outside the objective], the field being moderately illuminated. The conditions of this process are unfavourable to high precision, and moreover the reflected image is frequently difficult to pick up. In the new form of ocular the glass plate at 45° is replaced by the narrow reflecting face of a very thin prism, consisting simply of a slip of microscopic cover-glass, about 15 by 5 by 0·2 mm., having one end sliced off at 45°. It is this slant end which acts as reflecting face. The slip is inserted through a side tube, at right angles to the main tube, and is attached by wax to a metal plug with a knurled head, half the plug being cut away. The thin edge of the glass being presented to the eye, the slip interferes very little with the visual beam. Adjustment consists in bringing the black rear of the reflecting face into coincidence with the bright reflected image of its front, which is stated to be brilliant and easily seen in any part of the field of view. The field illumination is low owing to the smallness of the entering beam. The new ocular can be used for photometry by rotating the reflecting face 180° so that it faces towards the eye instead of towards the objective. Uniform illumination is secured by placing a fragment of opal glass over the orifice where the illuminating beam enters. This method has been used for measurements of diffuse light, but has not yet been tried for extra-focal star images. The thin reflecting prism has also been used successfully in microscopes for illuminating the object viewed.

A. E.

168. *Influence of Physical Conditions of a Substance on its Absorption of Light.* **G. H. Livens.** (Phil. Mag. 24. pp. 623–628, Oct., 1912.)—In a previous paper [Abstract No. 1889 (1912)] the author discussed theoretically the effect of the density of a gas on its line spectrum. The theory can be extended to give explanation of other experimental facts concerning the effect of the physical conditions of a substance on its absorption of light. The present paper deals with (i) The influence of the nature of the solvent upon the position of the absorption bands of the dissolved substance. (ii) Absorption in a gas. (iii) The broadening of the lines of a spectrum with increasing density. A. W.

169. *Spectropolariscopic Method for Investigating Light-absorption and the Nature of Colouring Matters.* **N. Umow.** (Phys. Zeitschr. 13. pp. 962–971, Oct. 15, 1912.)—The method depends on "chromatic depolarisation by scattering of light." In the case of substances which show a marked absorptive power, the depolarisation of the scattered light is small for the colours which are most absorbed, and great for colours to which the scattering-surface is transparent. The extent of the depolarisation is determined by using a Savart polariscope in conjunction with a spectroscope. The study of colour by this method has the great advantage that experiments can be made with substances which cannot be examined in solution, *e.g.* insoluble pigments, dyed fabrics, and natural objects. Nearly 200 illustrations are given as examples of the application of the method. T. M. L.

170. *Optical Constants of Metals.* **C. Zakrzewski.** (Acad. Sci. Cracovie, Bull. 8A. pp. 842–849, Oct., 1912.)—Starting with Kettler's formula for the phase-difference between the components, parallel and perpendicular to the plane of incidence, of the light reflected from a metal surface, the author develops mathematically formulæ giving the optical constants of the metal. These are applied to Drude's results for Ag, Ni, and Zn, and it is seen that there is good agreement between the values calculated from the formulæ and the experimental results. A. W.

171. *Density and Refractive Index of Liquids in Contact.* **A. L. Clark.** (Phil. Mag. 24. pp. 451–452, Sept., 1912.)—Chloroform which is nearly insoluble in water and has density 1·4 at ordinary temperature, has a critical density of about 0·5. The density of water at 260° (the critical temperature of chloroform) is about 0·66, so that as the temperature rises, the density of chloroform falls off more rapidly than that of water, and at one temperature they are equal. Chloroform and water were placed together in a Natterer's tube and heated in a paraffin bath. At a few degrees below the critical temperature of chloroform the equilibrium becomes unstable, and the system overturns, the chloroform rising to the top. On cooling, the chloroform sinks again to the bottom. The index of refraction of chloroform decreases more rapidly on rise of temperature than that of water. When the indices become equal the separating surface disappears from view, to reappear again when the temperature is raised still more. J. J. S.

172. *Carbon Disulphide as Solvent for the Determination of the "Refraction Constant."* **F. Schwers.** (Chem. Soc., Journ. 101. pp. 1889–1902, Oct., 1912.)—The author gives the following brief summary of conclusions drawn from an investigation of four systems: (*A*) In mixture with carbon disulphide, organic liquids (acids, alcohols) differ from the corresponding aqueous solutions in the following points: (1) The values observed for the density

and refraction are less than the theoretical values; the mixtures thus undergo a dilatation, and not a contraction, as is generally the case for aqueous solutions. (2) The values $C_v/C_w = A$ (refraction constant) are much less than for the corresponding solutions in water. (3) Moreover, there is no regular proportionality between the A values in water and carbon disulphide, which shows how much A is determined by constitutive influences. (*B*) In spite of these differences, carbon disulphide solutions have several properties in common with aqueous solutions: (1) If we examine the solutions of carbon disulphide successively with the different terms of a series, the value of A diminishes with the increase of the molecular weight. (2) Increase of temperature produces increase of A. (3) The refraction constant diminishes from the red to the violet of the spectrum. L. H. W.

173. *Optical Properties of Substances at the Critical Point.* **C. Smith.** (Roy. Soc., Proc. Ser. A. 87. pp. 366–371, Oct. 2, 1912.)—The author calculates that *all substances at the critical point must have the same refractive index*, namely, $n_c = 1{\cdot}126$ for light of infinite wave-length. Assuming that the specific refraction is constant for all temperatures, data are available for calculating the value of n_c for different substances. More data are available if the calculation is made for the D line instead of for light of infinite wave-length. From these data the critical refractive index has been calculated for 5 gases and vapours, 9 inorganic liquids and condensed gases, and 7 organic liquids. In the majority of these 21 cases "the percentage difference from the theoretical value is well within 1 %, whilst the greatest difference is only 2·2 %, but this presentation of the data includes the whole number of the refractive index, and it would be more correct to regard the errors as ranging from 10 to 22 %; the actual values range from 1·101 to 1·146, the "theoretical" value being 1·126. A further series of eleven substances, mainly halogen compounds and aromatic substances, shows much larger deviations, the value for bromine-vapour being as high as 1·194. T. M. L.

174. *Refraction and Magnetic Rotation of Mixtures.* **P. T. Muller** and **Mlle. V. Guerdjikoff.** (Comptes Rendus, 155. pp. 774–777, Oct. 21, 1912.)—Owing to some confusion of the prisms employed, the results previously given [Abstract No. 663 (1912)] are incorrect. It is now found that with aqueous solutions of LiCl and NH_4NO_3, the angle of rotation is practically a linear function of the refractive index, but that with mixtures of alcohol and aniline the relation is more complex. The value of $B = (a/a_0)/n^2(n^2 - 1)$, where n is refractive index, a the magnetic rotation, and a_0 the rotation of an equal quantity of water, increases with the concentration for the solutions of LiCl and aniline, but decreases with the concentration of NH_4NO_3. With the last mentioned, as also with solutions of sulphuric and acetic acids, an increase in the refractive index is in some cases accompanied by a decrease in the magnetic rotation. While the two phenomena are not necessarily independent, no *general* expression connecting them has yet been established. W. H. Si.

175. *Optical Constants of Metals.* **J. T. Littleton, Jr.** (Phys. Rev. 35. pp. 306–311, Oct., 1912.)—Gives a description of the determination of the values of n, the refractive index, and k, the absorptive index, for silicon and ductile tungsten, and of the effect of heat treatments on different steels. Observations have been made by v. Wartenberg on Si and W [Abstract No. 548 (1910)], and by Ingersoll and Littleton on Si [Abstract No. 225 (1911)].

Hagen and Rubens, also Drude, have determined *k* for steel, but do not give the carbon-content or previous heat treatment, so it is of interest to see whether the optical properties of the metal are affected by these two factors, which have so much influence on the physical properties of the material. Drude's method was used [Ann. d. Physik, 39. p. 481, 1890]. Observations were made at principal incidence (ϕ) and principal azimuth (ψ). Grinding was done with graded carborundum, and polishing with rouge. The results obtained for the Si used were: $n = 4{\cdot}24$, $k = 0{\cdot}118$, $\phi = 76^\circ 45'$, $2\psi = 6^\circ 52'$, and R (the reflecting power) $= 37{\cdot}8$ per cent. For W the corresponding values obtained were respectively 3·46, 0·94, 78° 31′, 44° 3′, 54·5 per cent. Steels of different carbon-content and different heat-treatment were used. They are divided into four classes: I, a mixture of the segregated particles of the carbides of iron in a matrix of pure iron, obtained by keeping the metal at about 600° C. for 24 hours or longer; II, very similar to I, the particles of the iron carbides being smaller, obtained by slow annealing from about 900° C., or by quenching from 900° C., reheating to about 600° C., and holding at that temperature for 8 or 10 hours; III, according to Campbell, a supersaturated solution of the iron carbides in α-iron, obtained by quenching from about 900° C., reheating to about 340° C., and holding at that temperature for 10 or more hours; IV, quenched or hardened steel, heated to about 900° C. for 30 mins., and quenched in ice water, giving a solid solution of the iron carbides in small γ-iron crystals. A table is given of the constants of all specimens used. Classes I and II give the same values for *n* and *k*, and Classes III and IV have the same value for *n*, which is different from that for I and II. Hence it is concluded that the carbides of iron have some effect on the iron molecule in both the hard steel and the troostitic form, which supports Campbell's theory. The decrease in *k* caused by an addition of carbon is so small that a change caused by heat treatment cannot be observed. But the changes in *n* caused by changes in the carbon-content and by heat treatments are quite large. Hence lack of similarity in these two factors would account for any lack of agreement between measurements of the optical constants of steels of unknown compositions and heat treatments. A. W.

176. *General Theory of Images.* **M. Wolfke.** (Ann. d. Physik, 39. 3. pp. 569–610, Oct. 15, 1912.)—Gives a general mathematical theory of the formation of images of objects self-luminous (*selbstleuchtender*) and non-self-luminous. The results of the theory are then tested experimentally, and some are found in conflict with the theory of Abbe but in harmony with the author's theory. [See Abstracts Nos. 228 and 1475 (1911).] E. H. B.

177. *Perception of Lights of Short Duration at their Range Limits.* **A. Blondel** and **J. Rey.** (Amer. Illum. Engin. Soc., Trans. 7. pp. 625–658; Discussion, pp. 658–662, Nov., 1912.)—A more complete account of the work dealt with in Abstract No. 1476 (1911).

178. *Trichromatic Theory of Colour Vision—the Measurement of Retinal Fatigue.* **W. de W. Abney.** (Roy. Soc., Proc. Ser. A. 87. pp. 415–427, Oct. 31, 1912.)

179. *Translation Series in Line Spectra.* **T. van Lohuizen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 156–165, Sept. 3, 1912.)—In a

previous paper the author showed how he had discovered series in the spectra of Sn and Sb by using a model based on a certain fundamental principle [see Abstract No. 1698 (1912)]. In the present paper it is shown how the same idea may be utilised in arranging the series of systems of the different elements in better order. A great deal has already been done in this direction by Rydberg, Kayser and Runge, and others, and particularly by using the "combination principle" of Ritz. But Mogendorff [Abstract No. 812 (1912)] has shown that Ritz's arrangement is not the only one, as most of the combinations are indicated as summational and differential vibrations. Hicks distinguishes four kinds of "sequences": (1) Principal (P) sequence, (2) Sharp (S) sequence, (3) Diffuse (D) sequence, (4) Fundamental (F) sequence. In connection with these it may be seen that when we confine ourselves to one component, all the series and combinations are formed from these four sequences. All the series and combinations may be graphically represented by one and the same curve, which is subjected to four different rotations with regard to the original system of axes. All the series that are represented by curves of equal rotation belong to one group, and differ only in asymptote. They may be changed into each other by a translation of the curve parallel to the y-axis. The author thus calls them *translation series*. The asymptotes may be found from a curve with the same or with another rotation. So every spectral line is determined by its number on the curve and by the asymptote of this curve. It is suggested that a uniform notation be adopted. The different series are denoted by Px, Sx, Dx, Fx, where $x = 1, 2, 3, \ldots$ The form of these series is somewhat different for the different spectral formulæ, but yet there is close agreement. The numerators are the same for all three (Ritz, Mogendorff-Hicks, v. Lohuizen), the universal constant 109675·0. The roots from the denominators contain three terms: the parameter (m or x), a constant (a, p, s, d, or μ), and the coefficient of the third term (b, π, σ, δ, or γ). It is suggested that the following symbols be adopted: x, (p, s, d, f), ($\pi, \sigma, \delta, \phi$). Thus v. Lohuizen's formulæ would be $\mathrm{P}x = 109675{\cdot}0/(x + p + \pi y)^2$, $\mathrm{S}x = 109675{\cdot}0/(x + s + \sigma y)^2$, etc., where x may be $1, 2, 3, \ldots$ Ritz's notation for the second subordinate series $x = 1{\cdot}5, 2{\cdot}5, 3{\cdot}5, \ldots$ is discarded, v. Lohuizen agreeing with Hicks's view in this respect. It may be noticed that in Fx, f differs very little from a whole number, and ϕ becomes practically zero. So the denominators differ little from 3^2, 4^2, etc. Then, using the principle that, in accordance with Ritz's theory, every spectral line is brought about by the difference of two actions, the designation of every spectral line is evident. We must state of what two terms of what two series its frequency is the difference. So the second line, for instance, of the principal series is represented by $\mathrm{S}_1 - \mathrm{P}_2$, the whole principal series by $\mathrm{S}_1 - \mathrm{P}x$. Omitting the negative sign for simplicity, we write $\mathrm{S}_1\mathrm{P}_2$ and $\mathrm{S}_1\mathrm{P}x$ for these respectively. *A priori* the following series are possible:—

I.	II.	III.	IV.
Pz Px	**Pz Sx**	**Pz Dx**	**Pz Fx**
Sz Px	*Sz Sx*	**Sz Dx**	**Sz Fx**
Dz Px	*Dz Sx*	*Dz Dx*	**Dz Fx**
Fz Px	*Fz Sx*	*Fz Dx*	**Fz Fx**

Up to now only one or more lines have been observed of the series in leaded type. The series in column I are *Principal Series*. They form together a group of Translation Series and differ only in asymptote. The above views are illustrated from the sodium series; a plate is given showing the different curves, all drawn from the same template, constructed with special care. The diagram throws light on the so-called summational and differential series discussed by Mogendorff and also on the combination principle of Ritz. It also appears that the principle of continuity would lead to the introduction of negative frequencies. A. W.

180. *Reflection of Röntgen Radiation.* **C. G. Barkla** and **G. H. Martyn.** (Nature, 90. p. 485, Dec. 19, 1912.)—Following the investigations of Laue, Friedrich, and Knipping, the authors studied the transmission of a narrow pencil of Röntgen-rays through rock-salt, a crystal of simple cubic form. The results showed a strong reflection from the internal crystallographic planes upon which the pencil fell at nearly grazing incidence. The pencil so reflected is of such intensity that the short exposure required to produce well-marked effects on a photographic plate is insufficient to give more than a trace of the most intense of the other pencils of radiation emerging from the crystal. The angle turned through by the reflected beam was within a very small possible error, the same as that turned through by the incident pencil. A small cleaved fragment of crystal was placed with one pair of faces horizontal, and a narrow pencil of Röntgen-rays was directed on the under surface in one of the three principal planes of the crystal. When the pencil of rays made a slight angle with the normal to the surface, the pencil was directed at nearly grazing incidence on one of the sets of vertical principal planes in the crystal. The result was a well-marked spot on the photographic plate situated several cm. above the crystal, on the same side of these crystallographic planes as the incident pencil. The effect was also observed on the other side of the normal. The results can be accounted for by the reflection from a large number of layers of atoms, parallel to one of the pairs of faces of the crystal. A. W.

181. *Absorption and Reflection of Homogeneous β-Particles.* **W. Wilson.** (Roy. Soc., Proc. Ser. A. 87. pp. 310-325, Oct. 2, 1912.)—By means of a magnetic field a homogeneous pencil was separated out from the β-rays emitted from a source of radium in equilibrium [see Abstract No. 1438 (1910)]. The β-rays transmitted through various foils were measured in a hemispherical ionisation chamber and curves obtained representing the absorption of homogeneous β-rays of various velocities by Al, Sn, and Cu. The results show that β-ray beams of high velocity can penetrate considerable quantities of matter (0·5 mm. Al) without appreciable reduction in intensity as measured by ionisation. The fact that β-rays, initially homogeneous, are absorbed by Al according to an exponential law after passing through a small thickness of Pt is confirmed by the experiments [see Crowther, Abstract No. 1607 (1910)], and this is shown not to be due to mere scattering of the rays, but to the fact that the beam is rendered heterogeneous in its passage through the Pt. It appears that on the passage of a homogeneous beam of β-rays through matter, some of the particles undergo more violent encounters with the atoms they traverse than others, and there is therefore a tendency for the beam to become heterogeneous. This proceeds until a definite state of equilibrium is reached, when the further passage of the beam through matter produces no further change in its properties, and the beam is then absorbed according to an exponential law. In such a beam the distribution of numbers of the particles composing

it with respect to velocity would not alter as it penetrated matter, the greater absorption of the particles of lower velocity being compensated by the decrease in velocity of a portion of the more rapid rays.

The author has also studied the reflection of homogeneous β-rays, and it is shown that the slow rays reflected when β-rays of UrX fall on matter [see Abstract No. 82 (1913)] are due to reflection of the slower portion of the primary beam. From the results it is deduced that there is no necessity to assume the existence of a real secondary when β-rays strike matter. E. M.

182. *Scattering and Absorption of β- and Röntgen-Rays in Crystals.* **J. Stark.** (Phys. Zeitschr. 13. pp. 973–977, Oct. 15, 1912.)—Previous experiments of the author have shown that canal rays penetrate further along special parallel planes of a crystal than along others [Abstract No. 1868 (1912)]. Developing this idea the author takes the view that in crystals the atoms are all arranged regularly so that parallel straight lines can be drawn passing through practically no atoms. With β-rays incident in such directions there will be abnormally little absorption, and adopting a corpuscular hypothesis the same will be true of X-rays. Similarly with β- or X-rays incident on a crystal we should expect certain peculiarities of scattering along these directions. The author claims that the general results of Friedrich and Knipping [K. Bayer. Akad. München, Ber. p. 303, 1912] can be as well explained on this hypothesis as on that of Laue. In these experiments a narrow beam of X-rays was directed on to a crystal plate of ZnS and regularly distributed spots were found to be produced on a photographic plate placed beyond the ZnS. Thus : (1) The size of the spots on the photographic plate is independent of its distance from the ZnS. (2) With thicker plates there is a greater intensity of the spots. (3) The positions of the spots are independent of the hardness of the X-ray bulb since they depend only on the "channels" in the crystals. (4) The spots are elliptical in shape, etc. E. M.

183. *Units of Quantity of Radium Emanation.* **J.** and **G. Danne.** (Archives d'Él Médicale, 20. pp. 521–527, Dec. 10, 1912. Paper read before the Assoc. franç. pour l'Avancement des Sciences, Nîmes, Aug., 1912.)—The International Congress at Brussels in 1910 decided on a unit for RaEm, this unit being the amount of emanation in equilibrium with 1 gm. Ra and being defined as a "curie." More convenient practical units for some purposes are the millicurie and the microcurie, equal to 10^{-3} and 10^{-6} curie respectively. In terms of the older units 1 curie $= 4{\cdot}80 \times 10^5$ gm. seconds or $2{\cdot}5 \times 10^9$ Mache units. [The gm. second is the amount of emanation produced by 1 gm. Ra per sec. The Mache unit is the quantity of RaEm without disintegration products which produces a saturation current of 10^{-3} e.s. unit in a chamber of large dimensions.] Such units as volt-hour, etc., which have often been used have no meaning apart from the capacity of the particular instrument employed. E. M.

184. *Velocity of δ-Rays.* **F. Hauser.** (Phys. Zeitschr. 13. pp. 936–940, Oct. 1, 1912.)—Previous experiments of the author [Abstract No. 1501 (1911)] have been criticised by Campbell [Abstract No. 1085 (1912)], who affirms that from measurements of the p.d. between two electrodes on one of which α-particles are falling, very little information can be obtained as to the velocity of the secondary δ-rays. Campbell's objection arises partly from the fact that a very large field is required to completely drag out the

negatively-charged δ-rays from a plate. In the present experiments the author shows that this effect is only pronounced when dealing with rough surfaces such as carbon or soot. With smooth surfaces, using polonium, practically all the δ-rays come out without a field, whether from the plate on which the polonium is deposited or from an electrode on which the α-particles are falling. The velocity distribution of the δ-rays was determined from the values of the potential required to prevent their escape from a plate, and found to be about that of Maxwell for the distribution of the velocities of the molecules in a gas. However, from a "poloniumised" plate δ-rays could be detected with velocities up to the values corresponding to a fall of potential of from 88 to 48 volts, while from an electrode on which the α-particles fell, the max. velocities detected corresponded to only 15–20 volts. Higher velocities were presumably not observed in both cases owing to the small number of particles to be expected. The mean velocity of the secondary δ-rays was determined to be from 4 to 10 volts, the more frequently occurring having velocities not greater than 6 volts. E. M.

185. *Radio-activity of Water issuing from Monte Amiata, and Atmospheric Dispersion in the Neighbourhood.* **R. Nasini** and **C. Porlezza**. (Accad. Lincei, Atti, 21. pp. 476–478, Oct. 27, 1912.)—A redetermination of the radio-activity of the water from several springs on Monte Amiata some twelve months after the first examination [Abstract No. 1210 (1912)], and following an unusually dry period, gives results very similar, with one exception, to those previously obtained, and shows this property of the waters to be fairly constant. The atmospheric dispersion was also not appreciably different. W. H. Sı.

186. *Estimation of Emanation Content of Spring Waters.* **G. Berndt**. (Ann. d. Physik, 38. 5. pp. 958–986, Aug. 18, 1912.)—The paper is theoretical and deals with a calculation of corrections necessary for the time since the water was collected, etc. Following the results of Duane and Laborde [Abstract No. 926 (1910)] the author concludes that in terms of the initial and max. α-ray activity of RaEm enclosed in a cylindrical ionisation vessel of internal area O, and volume V (at 760 cm. and 15° C.), 1 Mache unit is equal to $\lambda/1000 \times 5{\cdot}2(1-0{\cdot}52\ O/V)$ and $\lambda/1000 \times 18{\cdot}15(1-0{\cdot}52\ O/V)$ respectively; λ being the disintegration constant of RaEm, *i.e.* $2{\cdot}08 \times 10^{-6}$. E. M.

187. *Fluctuations in the Ionisation Produced by γ-Rays.* **E. Buchwald**. (Ann. d. Physik, 39. 1. pp. 41–52, Sept. 5, 1912.)—The author, continuing the work of E. Meyer and others, has made a mathematical investigation of the variations produced in the ionisation from a constant source of γ-rays. E. M.

188. *The Discovery of Radio-activity, and its Influence on the Course of Physical Science.* **O. Lodge**. (Chem. Soc., Journ. 101. pp. 2005–2042, Oct., 1912. Becquerel Memorial Lecture.)

189. *Emanation from the Soil to the Atmosphere.* **L. B. Smyth**. (Phil. Mag. 24. pp. 682–687, Oct., 1912.)

HEAT.

190. *Thermostat with Air-heating.* **F. Göpel.** (Zeitschr. Instrumentenk., Beib. 20. pp. 209–211, Oct. 15, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—Describes a large thermostat, the inside space having a base area of 50 × 75 cm.^{2}, and height 80 cm. The inner walls are of sheet copper and the outer of sheet zinc. The base of the outer case is continuous, but the base of the inner case has a space 25 mm. in width between it and the sides. The double-walled space is closed at the top by a strong glass plate, 5 cm. below which is another provided with a rectangular opening. The walls between the two glass plates are provided with holes. The heating of the circulating air is effected by means of a flat ring-shaped coil, electrically heated, over which the air must pass. The thermostat has an outside casing, which gives outside the zinc case an air-space, then a layer of cork, then another air-space, and last the outer cover of wood. Temperature researches show that inside the thermostat the temperature can without difficulty be maintained constant to 0·1 deg. Two cooling experiments (after stopping the motor for the heating) gave for 4 deg. temperature-difference between the room and the thermostat a cooling of 0·013 deg. per min., for 6 deg. temperature-difference a cooling of 0·021 deg. per min. For further details the diagrams in original paper should be consulted. A. W.

191. *Dilatation of Steel.* **W. Block.** (Kaiserl. Normal-Eichungs Kommission, Wiss. Abhandl. No. 8. pp. 59–69, 1912.)—By means of the Fizeau interference dilatometer, used with helium lines, the dilatation of hardened and tempered samples of steel in ranges of 40 deg. or 80 deg. were in one instance (12·01 + 0·0110T) μ, and in another (12·96 + 0·0163T) μ. The mean value gives 12·76 μ at 20°. Three unhardened samples of the same steel gave the following results :—

(10·06 + 0·0136T) μ per metre.
(10·51 + 0·0091T) μ „
(10·28 + 0·0115T) μ „
Mean (10·28 + 0·011T) μ „

and, at 20°, 10·50 μ per metre. Attention is drawn to the marked difference between the hardened and unhardened samples. The effect is, however, more marked in a small sample, because the hardening is more complete. The following values are suggested for use, as being correct to about 2 % :— For pieces with dimensions about 100 mm., 11 μ; 50–20 mm., 11·5 μ; 20–10 mm., 12 μ; 10 mm. and less, 12·8 μ. F. R.

192. *Apparatus for Boyle's Law.* **P. Gehne.** (Phys. Zeitschr. 13. pp. 946–948, Oct. 1, 1912.)—Describes a small apparatus for the demonstration of Boyle's law, and adapted for projection with an ordinary lantern. A horizontal capillary glass-tube (C) has a small air-bubble at the closed end; the other end is connected to a manometer tube (M), and a side connection from M leads to a longer vertical tube (V). M is completely filled with mercury at first, V being about one-third full, and the apparatus is then evacuated, and the top of V sealed. V contains also a glass rod, to the upper

end of which a short iron cylinder is attached. The pole-pieces of an electromagnet fit round the tube V, and so by raising or lowering the magnet the glass rod may be moved to any desired position inside the tube, thus giving a ready means of altering the level of the mercury inside. The pressure of the air-bubble in C is measured by the height of the mercury in M above the horizontal tube C, and the volume is determined by the length of tube filled. Both the tubes C and M are provided with appropriate glass scales, and these are shown on projection, so that Boyle's law may be easily demonstrated to a class. In addition, a thin wire, bent into the proper hyperbola curve for the apparatus, and fixed relative to two axes, also of wire, is adjusted so that the end of the mercury thread in C lies on the curve, while the horizontal axis coincides with the level of the mercury in M. The curve with its axes is connected by a string passing over two pulleys to the movable electromagnet, and as the latter moves up or down the horizontal axis moves down or up, and thus always coincides with the level of the mercury in M. As the wires are projected with the rest of the apparatus, it is easy to see how the end of the mercury thread in C always lies on the curve. A. W.

193. *Dilatation of Solids.* **W. Block.** (Kaiserl. Normal-Eichungs Kommission, Wiss. Abhandl. No. 8. pp. 73–84, 1912.)—The difference between the expansions of a rod of known dilatation and the specimen is measured by attaching a knife-edge to one end of the standard rod, and resting one end of the specimen on this. Between the other ends is supported a double knife-edge carrying a mirror, whose movements are observed in the usual way. The results for three samples of galvanised iron telegraph wire per 1 deg. C., per metre at 18° C., ranged from 11·65 μ to 11·78 μ, including strained specimens. A mean result for two samples of ebonite was 94 μ per 1 deg. C. per m. at 20°. An Al alloy containing, besides Al, chiefly Cu 7·23 and Zn 2·9 per cent., gave 22·7 μ at 26° C. Another with 4·93 per cent. Cu gave 23·1 μ at 25·5°. Another with 4·38 Cu, 0·72 Mn, 0·58 Mg gave 22·5 μ at 25·5°. These results are slightly lower than the figure 23·5 μ usually given for Al.

F. R.

194. *Rise of Temperature near Melting Icebergs.* **H. T. Barnes.** (Engineering, 94. pp. 809–810, Dec. 13, 1912. Nature, 90. pp. 408–410, Dec. 12, 1912.)—The author withdraws certain statements made in his Royal Institution lecture [Abstract No. 1010 (1912)]. Taking measurements in the Straits of Belle Isle, he finds that the temperatures of the water decreased as the distance from the iceberg increased, *e.g.* from 5·2° to 3·6° C. in a distance of 5 miles. With the assistance of McIntosh and O. Maass he also observed that the density of the water near the iceberg was not appreciably diminished by the melting ice, because the bergs melted slowly. He therefore adheres only to the first two of O. Pettersson's three suggestions, which he had previously supported: The melting of ice in salt water produces three currents: (1) a current of sea water cooled by the ice, sinking downward; (2) a current of warm water moving towards the ice; (3) a current of light fresh water from the ice, rising and spreading over the surface of the sea. The white colour of icebergs, he further states, is due to air bubbles, which makes the melting ice effervesce in experiments, and may account for the explosion of icebergs; the cooling effect produced by land is confirmed. H. B.

195. *Specific Heat of some Elements at Low Temperatures.* **T. Estreicher** and **M. Staniewski.** (Acad. Sci. Cracovie, Bull. 8a. pp. 834–841, Oct.,

1912.)—The method of mixtures was used, the element of which the specific heat was to be determined, being cooled to —190° in liquid air, or to —80° in solid CO_2 and alcohol, and then introduced into water or toluene in the calorimeter. In the case of bromine and iodine the elements were sealed up in glass bulbs, whereas with sodium and potassium cylinders of the pure metals were wrapped tightly in tin-foil, whereby oxidation was prevented. The following specific heats were obtained, the temperature range being indicated in brackets: Toluene, 0·4015 ± 0·0008 (14° — 17·5°); bromine, 0·07016 (— 192° to — 80°), the atomic heat being 5·61; iodine, 0·0454 (— 191° to — 80°) and atomic heat, 5·76, 0·04852 (— 90° to + 17°), atomic heat, 6·16; sodium, 0·2478 (— 191° to — 80°), the atomic heat being 5·70, 0·2714 (— 80° to + 17°), atomic heat, 6·24; potassium, 0·1551 (— 191° to — 80°) and atomic heat, 6·06, 0·16771 (— 80° to + 18°), atomic heat, 6·56; manganese, 0·08208 (— 188° to — 79·2°), atomic heat, 4·505, 0·10906 (— 79·2° to + 15°), atomic heat, 5·99.
T. S. P.

196. *Radiation Constant.* **L. Puccianti.** (N. Cimento, 4. Ser. 6. pp. 322–330, Oct., 1912.)—The author has made a further determination of the radiation constant of a black body, neutralising the heat lost by one black body at the ordinary temperature to another black body at the temperature of liquid air by the Joule effect of an electric current, and determining directly the p.d. and the resistance of the conductor. The method is not so sensitive as the bolometric one previously described [Abstract No. 1858 (1912)], but the value of σ is found to lie between 6·00 and $6{\cdot}80 \times 10^{-12}$. W. H. Sı.

197. *Denial of Kirchhoff's Law for Heterogeneous Bodies.* **W. Voigt.** (Phys. Zeitschr. 13. pp. 848–852, Sept. 15, 1912.)—A mathematical discussion of the proportionality of emission and absorption, in which it is maintained that this proportionality (asserted by Kirchhoff) has only so far been established for homogeneous bodies. [See Abstracts Nos. 551 (1910) and 1368 (1912).] E. H. B.

198. *Determinations of the Vapour Tension of Nitrogen Tetroxide.* **F. E. C. Scheffer** and **J. P. Treub.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 166–178, Sept. 8, 1912.)—The critical temperature of nitrogen tetroxide, observed by reflected light in a paraffin bath, is found to be 158·2°. The vapour tension has been observed in a manometer similar to that used previously [compare Abstract No. 518 (1912)], but more elongated and smaller. In one form of the apparatus the manometer is enclosed in a combustion tube attached to a Cailletet apparatus and provided with an outer jacket containing liquid, which may be heated electrically. The highest pressure thus obtainable is 67 atmos., which is below the critical pressure. In a second form of apparatus the combustion tube is replaced by a copper tube, provided with transverse tubes opposite the needle of the manometer, closed with glass plates cemented into steel mounts by an enamel of sodium and potassium carbonates, lead oxide and silica. The copper tube is surrounded by two spiral lead tubes, through which heated oil is circulated in opposite directions. A pressure of 150 atmos. may be reached. The critical pressure is 100 ± 2 atmos. Calculation shows that at the critical point the substance must consist almost entirely of NO_2-molecules. The calculated heat of evaporation at the boiling-point is 9200 gm. cals. T. S. P.

SOUND.

199. *Axial Emission of Sound in a Cylindrical Tube.* **M(ary) Taylor.** (Phil. Mag. 24. pp. 655–664, Oct., 1912.)—A mathematical treatment of a problem suggested by Rayleigh's "Sound" (art. 301). The result is obtained that, in the absence of dissipative forces, the emission of energy by the source is a *discontinuous* function of the frequency. If the frequency is gradually increased, the emission tends to become infinite as the frequency approaches any one of a series of critical values, but becomes finite again *immediately* on passing these. An attempt is made to show the manner in which dissipative forces will affect the above results. E. H. B.

200. *Maintenance of Vibrations by Variable Spring.* **C. V. Raman.** (Phil. Mag. 24. pp. 513–520, Oct., 1912.)—This paper deals with the maintenance of vibrations by a periodic variation of the spring to which the system is subject. The matter is treated analytically, and it is shown that with the relations of frequencies contemplated the energy supplied compensates for that dissipated. The maintenance in question is then experimentally realised, and fifteen photographs show the figures obtained by a point on a string maintained in vibration by a fork on the principle of Melde's experiment. The relation referred to is illustrated as follows: If the frequency of the imposed variation of spring is 60 per sec., then, under suitable circumstances, vibrations would be maintained on systems whose free periods are nearly equal to 30, 60, 90, 120, 150, etc. E. H. B.

201. *Photography of Sound-waves.* **A. L. Foley** and **W. H. Souder.** (Phys. Rev. 35. pp. 373–386, Nov., 1912.)—Describes the photograph of the sound-waves from an electric spark by a point source shadow method very similar to that used by C. V. Boys in 1892 for the photography of "flying" bullets and their accompanying shells of compressed and rarefied air. Thirty excellent reproductions of the photographs accompany the paper. These include plane and spherical reflection, spherical refraction at lenses of SO_2 and CO_2, and diffraction at plane and curved gratings. E. H. B.

202. *Upper Partials of Tuning-fork.* **F. H. Parker.** (Nature, 90. p. 361, Nov. 28, 1912.)—Calls attention to the use of the fall plate to obtain on its smoked surface traces of the fundamental and upper partials of a tuning-fork, and thus ascertain their frequency ratios. Smoke traces were taken and a reproduction is given. The prime had a frequency of 29·5, and the upper partials were theoretically expected to have frequencies of the order 185 and 510, while the experimental numbers from single observations of each were 184 and 512 respectively. E. H. B.

203. *Exhibition of Phonographic Waves.* **H. Benndorf** and **R. Pöch.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1811–1832, Dec., 1911. 24th Report of the Phonogramm-Archivs-Kommission.)—Describes an apparatus for making traces of the waves in a phonograph plate. A needle passes between two pairs of rollers to feel the waves and its motion is magnified by two levers whose arms are 5 to 100 mm. and 6 to 400 mm. respectively. [See Abstract No. 257 (1909).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

204. *Magnetic Force on Moving Electrons.* **L. de la Rive.** (Archives des Sciences, 34. pp. 266–267, Sept., 1912. Paper read before the Soc. Suisse de Physique, Altdorf, Sept. 10, 1912.)—A new mathematical treatment of the motion of an electron in a magnetic field. Its result is summarised as follows:—"The identity of the Biot-Savart force with the composite centrifugal force, which in the case of negative charges are contrary in direction, produces in the case of rotating axes the disappearance of the centrifugal force and the appearance of an attractive force proportional to the distance." E. E. F.

205. *Model of a Radiating Atom.* **K. F. Herzfeld.** (Akad. Wiss. Wien, Ber. 121. 2A. pp. 598–601, April, 1912.)—Thomson's positive atom is modified so as not to contain the same density of positive electrification throughout, but a density varying at various depths. The electrons revolve in concentric circles only. It is then shown that a model may be obtained which emits Balmer's series of hydrogen lines. E. E. F.

206. *Multiply-charged Atoms.* **J. J. Thomson.** (Phil. Mag. 24. pp. 668–672, Oct., 1912. Paper read before the Mathematical Congress, Cambridge, Aug., 1912.)—In the photographs of the positive rays the Hg line is remarkable for the exceptionally small displacement of the head of its parabola [see Abstract No. 1870 (1912)]. Even when the electric and magnetic fields are strong enough to produce deflections of several mm. in the heads of the parabolas corresponding to the other elements, the head of the Hg parabola is so little deflected that it seems at first to coincide with the origin. When, however, the electric field is very large (from 5000 to 10,000 volts per cm.) the head of this parabola is found to be displaced by $\frac{1}{8}$ of the normal displacement of the heads of the parabolas corresponding to the other elements. The displacement due to the electric field is inversely proportional to the kinetic energy of the particle displaced, so that the atoms which produce the head of the Hg parabola must have 8 times the max. amount of energy possessed by the normal atoms. This could be accounted for if some of the Hg atoms in the discharge tube had lost 8 corpuscles. The plates taken with large electrostatic deflections show the existence of 7 parabolas due to Hg; the eighth has not been detected, but as the parabolas get in general fainter for each additional charge on the atom, the parabola corresponding to 8 charges is probably too faint to be detected. The question arises as to how the Hg atom acquires these very various charges. Reasons are given, based on examination of the photographs, for believing that there is no ionisation of such a kind as to deprive the Hg atom of 7, 6, 5, 4, 3, or 2 corpuscles, but that there are only two types of ionisation. In the first method the ionising agents are the rapidly moving corpuscles which constitute the kathode rays; these very small particles penetrate into the atom and come into collision with the corpuscles inside it individually, the collision in favourable cases causing the corpuscle struck to escape from

the atom; this type of ionisation results in the atom losing a single charge. In the other type of ionisation we suppose that the Hg atom is struck by a rapidly moving atom and not by a corpuscle; after the collision the Hg atom starts off with a very considerable velocity, which at first is not shared by the corpuscles inside it. Thus if there were 8 corpuscles in the Hg atom connected with about the same firmness to the atom, the result of the atom acquiring a high velocity by collision might be the detachment of the set of 8, leaving the atom with a charge of 8 units of positive electricity. The atoms with from 2 to 7 units of positive electricity must be supposed to have regained 6 to 1 corpuscles subsequently. All the elements examined give multiply-charged positive atoms with the exception of hydrogen, on which never more than one charge has been observed. The majority of the elements seem to acquire only two charges. Nitrogen atoms have been observed with 3 charges, but the parabola due to the triply-charged atom is exceedingly faint. Argon shows triply-charged atoms very distinctly. The argon plate shows the He line, and from this it is concluded that in a volume of about 2 litres of argon at 1/300 mm. Hg pressure a quantity of He occupying only 4×10^{-6} c.cm. at atmospheric pressure could be detected. An interesting result, which is being further investigated, is that when very pure nitrogen is in the discharge-tube the Hg line corresponding to the atom with 5 charges becomes abnormally bright, brighter than those for the atom with 4 or even 3 charges, though in other gases the greater the charge the fainter the line. A. W.

207. *Atomic and Molecular Charges.* **F. Sanford.** (Phys. Rev. 35. pp. 276–281, Oct., 1912.)—Forms estimates of the atomic and molecular charges from the work of J. J. Thomson and of Knipp, and thus shows that for a number of Li-, Na-, and K-salts the relations (i) between heat of formation and molecular charge, and (ii) between solubility and charge are each linear. Hence the same law holds between the heat and the solubility. E. H. B.

208. *Coefficients of the Lorentz Transformation.* **C. Kraft.** (Acad. Sci. Cracovie, Bull. 5a. pp. 385–415, May, 1912.)—Calculates the coefficients for the case when the two systems of co-ordinates have no common axis, but are inclined to one another at any angle. The treatment is based on the relativity principle. E. E. F.

209. *Unipolar Induction and Condenser Rotating in Magnetic Field.* **E. H. Kennard.** (Phys. Zeitschr. 13. pp. 1155–1157, Dec. 1, 1912.)—The author's conclusions [see Abstract No. 1859 (1912)] having been contested by Barnett, the matter is treated analytically, and the author considers that the experiments of Barnett and himself support the view that in unipolar induction the e.m.f. has its seat in the moving part, whichever this may be, and that they contradict the simplest form of the theory of moving lines of force. G. E. A.

210. *Electromagnetic Induction and Relative Motion.* **S. J. Barnett.** (Phys. Zeitschr. 13. pp. 803–805, Sept. 1, 1912. Phys. Rev. 35. pp. 323–336, Nov., 1912.)—A cylindrical condenser, short-circuited by a wire, brought into a uniform magnetic field parallel to the axis of the condenser, and rotated round its axis while the magnet (or coil) remains fixed in position, becomes charged to a certain voltage; this voltage is equal to the product of the angular velocity into the magnetic flux through the annular space between the two condenser plates. If, on the other hand, the condenser and its appurtenances are fixed while the magnet (or coil) is rotated, the relative movement is the same, but the question remained whether the condenser becomes charged to the same extent as before. The author's results give a decided answer in the negative, the resultant charge being, within the limits of error, equal to zero. Then follows a discussion of the history of the question and of its bearings on the problem of unipolar induction. This problem cannot be solved by experiments on closed circuits or by any of the electrostatic methods hitherto proposed. A. D.

211. *Changes in Dielectric Constant by Strain.* **E. P. Adams** and **C. W. Heaps.** (Phil. Mag. 24. pp. 507–518, Oct., 1912.)—One of the present authors previously obtained the following expression for the fractional elongation of a charged thin cylindrical condenser, open at the ends, $e = -(V/d)^2(\delta_1 + \delta_2)\sigma/K$, where d is the thickness of the dielectric and is small compared with its internal radius, V is the p.d. to which the condenser is charged, σ is Poisson's ratio, and K the specific inductive capacity of the dielectric; δ_1 and δ_2 are two constants of the dielectric: the former the change in K for unit strain along the lines of force, and the latter for unit strain in a perpendicular direction [see Abstract No. 528 (1912)]. The present paper deals with experimental determinations of the deltas for hard rubber, soda glass, and Jena glass. It is found that for these solid dielectrics (as for fluid dielectrics) the two deltas are practically equal. The values are then as follows :—

Dielectric.	Hard Rubber.	Soda Glass.	Jena Glass.
Value of $(\delta_1 + \delta_2)$	−2·56	−3·14	−8·4

On the erroneous theory of electrostriction the elongation to be expected is given by $e' = (V/d)^2 K/8\pi E$. The ratio of the two expressions for elongation is $e/e' = -(\delta_1 + \delta_2)\sigma/K$. For the soda glass and Jena glass the values of this ratio are of the order 0·07 and 0·25 respectively. E. H. B.

212. *Electrification by Liquid Dropping.* **K. v. Bernolák.** (Ann. d. Physik, 39. 3. pp. 497–518, Oct. 15, 1912.)—An experimental research from which the following conclusions are drawn :—(1) The phenomena of electrification by the separation of liquid drops at a pipe end (noticed by Holmgren and later by Trübi) was confirmed under most rigorous conditions. (2) The magnitude of this effect depends essentially on the type of the drop formation, and is not fixed simply by that of the primary drops. (3) The electrification depends largely on the formation of the smaller or secondary drops which occur between the primary ones. (4) The magnitude of the electrification depends on the number and speed of formation of these secondary drops (or droplets). (5) When the sudden development of these droplets is hindered the electrification may be diminished by 30–80 per cent. E. H. B.

213. *The Large Ions in the Atmosphere.* **J. A. McClelland** and **H. Kennedy.** (Roy. Irish Acad., Proc. 30. 5. pp. 72–91, Dec., 1912.)—For the purpose of the experiments a special apparatus was constructed to the authors' design, and attention was first directed to the question of whether the large ions are all of the same mobility or whether they are a mixture of ions of different masses. The former was found to be the case, and the value for the mobility, 1/3100 cm. per sec., is in good agreement with that given by Langevin. No indication was found of ions of a mobility of 1/100 cm.

per sec. as found by Pollock. Assuming that each ion carries the electronic charge the number of large ions per c.cm. was found to vary from 3700 to 60,000, the average number being 16,000. There was no difference between the number of positive and negative ions. Some experiments were made on the power of reproduction of large ions in air which has been previously freed from them. As regards the nature of the ions the conclusion is reached that they consist of invisible water drops which have combined each with one small ion. The probable capture of large ions by the type of apparatus commonly employed to measure the number of small ions present in the atmosphere throws great doubt on the accuracy of the figures usually given for this number. It is pointed out that the observations recorded in the paper were all made in impure town air. J. S. Di.

214. *Electric Screening by Silver Films.* **[Miss] S. Hyatt.** (Phys. Rev. 35. pp. 337–346, Nov., 1912.)—By experiments on an electroscope inside a cage having a hole at the top covered by a glass plate bearing a silver deposit on one side, it was found that at some limiting thickness between 30 to 50 *μμ* a silver film when used as part of a hollow conductor becomes opaque to electrostatic induction from outside. E. H. B.

DISCHARGE AND OSCILLATIONS.

215. *Effect of a Magnetic Force on the Motion of Negative Ions in a Gas.* **J. S. Townsend** and **H. T. Tizard.** (Roy. Soc., Proc. Ser. A. 87. pp. 357–365, Oct. 2, 1912.)—When the velocity of an ion in a gas is proportional to the electric force (X) and inversely proportional to the pressure (P) the size of the ion is unaltered by changes in either. For a large range of pressures this condition holds, but for low pressures the velocity of the negative ions undergoes large changes when small variations are made in either X or P. The increase in mobility may be explained on the hypothesis that the mass associated with the negative ion diminishes at low pressures. The present experiments were made to investigate this, and to find to what extent the electrometric state prevails as the pressure is reduced. A stream of negative ions moving with a constant velocity under a small electric force was obtained by allowing them to pass through a slit into the electric field. The stream fell on a system of parallel electrodes, and could be deflected by a small magnetic field (about 14 e.m. units). From considerations of disturbances by diffusion the experiments were generally carried out at pressures from 3 to 10 mm. of Hg. The mean value of *e/m* for the ions in the stream was deduced from the amount of deflection caused by the magnetic field. Even at the higher pressures the results showed that the electrons cannot be associated with the molecules continuously. With a force of 2 volts/cm. and a pressure of 38 mm. Hg the mean value of *e/m* was found to be 4×10^{17}. The value of *e/m* when *m* is a molecule of air is 10^{13}, and for an electron it is approximately $5{\cdot}3 \times 10^{17}$. This shows that under these circumstances of pressure and electric field (with dry air) the ion must be in the electronic state while travelling between most of the collisions with molecules. Further investigations are in progress at lower pressures and with higher electric forces. E. M.

216. *Kinetic Theory of Ionised Gases.* **Gouy.** (Comptes Rendus, 155. pp. 633–636, Oct. 14, 1912.)—Considers a gas maintained adiabatically at a temperature such that a very small portion of its molecules are dissociated into ions. Shows that if the gas is contained in a magnetic field, this field, together with gravitation, impresses upon the ions a motion normal to both fields, which is in opposite directions for the positive and negative ions respectively. This motion is only annulled by collisions if the gas is dense. The movements are co-ordinated, which is not the rule in thermal agitation. If two opposite walls were metallic plates joined by a wire, a continuous current could be maintained in them by means of a permanent magnetic field, which plays the part of Maxwell's "demon." Probably Carnot's principle must be considered to fail in this case. E. E. F.

217. *Diffusion of Ions into Gases at Low Pressure.* **C. E. Haselfoot.** (Roy. Soc., Proc. Ser. A. 87. pp. 350–357, Oct. 2, 1912.)—Townsend has previously determined the charges on ions produced by Röntgen- and radium-rays in air by a method depending on their diffusion. In the present paper accurate experiments are described using the same type of apparatus and Ra as source of ionisation. The ions are made to pass in a parallel stream through a slit into a steady longitudinal electric field. Owing to diffusion the stream spreads out, and the ratio of the amounts received by a central disc electrode and an outer ring is determined. From the various quantities involved—pressure, field, etc.—the value of N*e* is determined [see Abstract No. 518 (1909)], where N is the number of molecules per c.cm. of gas at standard pressure and *e* is the elementary charge. The mean values obtained are $1{\cdot}22 \times 10^{10}$ for both positive and negative ions. The author has also made experiments with ultra-violet as source of ionisation, this being particularly advantageous for experiments at low pressures for which Townsend found an abnormal increase in the rate of diffusion for gases which had been thoroughly dried. The results are in general agreement with those of Townsend, and are discussed from the point of view of the tendency of the ions to assume the electronic state, the prevalence of this state depending on exactly the same conditions as those under which the abnormal increase in the rate of diffusion occurs. E. M.

218. *Lack of Symmetry of Positive and Negative Ions relative to the Condensation of Water Vapour in an Atmosphere of* CO_2. **Besson.** (Comptes Rendus, 155. pp. 711–713, Oct. 14, 1912.)—The apparatus used was described in a previous paper [see Abstract No. 1540 (1911)]. The CO_2 is submitted to the action of Röntgen-rays for 2 secs., and arrangements are made for establishing a field of 4 volts which can be reversed at will. The rain or fog which results from the condensation upon the negative ions when in excess, is much more intense than is the case with positive ions in excess. This phenomenon is much more apparent in CO_2 than in air. The fogs obtained have been photographed at 2 to 5 secs. after their production, and it is noted that in the absence of a field the condensation commences with an expansion of 1·33; the number of drops increases gradually until expansion 1·37 is reached, at which point the increase is clearly a maximum. The fog, however, increases still further in density up to an expansion of 1·476; above this value there is very little increase, and at 1·52 it apparently ceases. The lack of symmetry is visible for all expansions up to 1·476; for this value and for all higher degrees of expansion it can no longer be seen. It is very singular that the fog obtained without the field is practically identical with that seen when the negative ions are in excess, and this is so for all degrees of expansion,

while with air the fog obtained without the field is much more intense than when the negative ions are in excess. When Ra is used as the ionising agent it is found that the inferior limit of the degree of expansion is the same as with Röntgen-rays; the want of symmetry is observed but is less marked; and the anomaly noticed with Röntgen-rays, does not occur. A. E. G.

219. *Magnetic Rays.* **A. Righi.** (Accad. Lincei, Atti, 21. pp. 811–815, Sept. 22, 1912.)—A reply to the criticism of More and Rieman based on their observation that magnetic rays are only formed in mixed gases containing nitrogen, and not in oxygen, hydrogen, CO_2, or illuminating gas [Abstract No. 1876 (1912)]. The author points out that magnetic rays are only formed within a narrow range of pressures, p.d.'s, and magnetic fields, and doubts that the experiments with other gases were sufficiently varied. The velocity of the electrons forming magnetic rays should not exceed 222 km./sec. It is natural to suppose that electrons emitted by different substances possess different velocities, and these may not be suitable for forming magnetic rays. E. E. F.

220. *Secondary Rays Liberated by Canal Rays.* **H. Baerwald.** (Deutsch. Phys. Gesell., Verh. 14. 19. pp. 867–874, Oct. 15, 1912.)—It has been shown [see Abstract No. 1564 (1912)] that the ability of canal rays, which have been analysed by an electric field, to produce the emission of light by phosphorescent substances differs according to their position. Through the comparison of the intensity of the phosphorescence with the energy of the exciting canal rays, it appears that not all the rays in the pencil are light-producers, but that this effect is in some way connected with the electric charge. The degree of action of charged is greater than that of uncharged particles. On the other hand, no difference was found between the action of positive and negative particles. The present experimental arrangements are the same as those previously described (*loc. cit.*). Quantitative results are shown in both tabular and graphical form. From these it is concluded that the excitation of secondary radiation by canal rays is dependent essentially only upon the number of the particles striking, and that a specifically greater efficiency (as in the case with the excitation of phosphorescence) of the charged over the uncharged particles does not exist. This result it appears can be explained by the fact that the phosphorescent substances are good insulators, and so the charged canal rays keep their charges, while when these rays strike against a metal they lose that charge and can now only act as uncharged particles so far as the generation of secondary rays is concerned. A. E. G.

221. *Photoelectric Effect in Toluene.* **A. Naccari.** (Accad. Sci. Torino, Atti, 47. p. 1076. N. Cimento, 4. Ser. 6. pp. 233–242, Sept., 1912.)—A plate of nickelled copper or other metallic plate is inserted upright in a trough filled with toluene. In front of the plate, and distant from it about 1 mm., is a piece of wire gauze. The plate and the gauze form electrodes for a current from about 100 cells. The current, which is of the order of 0·1 microamp., shows a gradual increase when the cell is exposed to daylight. This increase takes about a minute to start, and goes on for some 10 mins., amounting to some 20 per cent. After that the current spontaneously falls off, reaching its "dark" value after about another 10 mins. The effect is not due to heat. Infra-red rays produce about one-quarter of the effect. Blue light is more effective than red. The influence of the kind of metal is insignificant, though the effect is greater when the metal is illuminated as well as the liquid. The effect differs from the Becquerel photo-voltaic effect in that it only takes place when a current passes, and from the Hallwachs-effect in that it is independent of the direction of the current. E. E. F.

222. *Photoelectric Fatigue.* **A. Becker.** (Deutsch. Phys. Gesell., Verh. 14. 16. pp. 806–811, Aug. 30, 1912.)—In reply to criticisms by Hallwachs [Ibid. 14. 12. pp. 634–646, June 30, 1912] based upon Ullmann's investigations [Abstract No. 960 (1910)], the author publishes figures which show that, whether the mercury lamp is at a great or small distance, moist air in the neighbourhood of the photoelectric surface is capable of entirely abolishing fatigue for several hours' working. E. E. F.

223. *Influence of the Nature of the Gas on Disintegration by Canal Rays.* **V. Kohlschütter.** (Zeitschr. Elektrochem. 18. pp. 837–844, Oct. 1, 1912.)—The author alters his experimental arrangement. The bulb has two tubular diametrical attachments, from which the electrodes (Al cylinders joined to copper wires) project into the bulb; a third cylindrical attachment projects downward and can be lowered into an electric furnace; the cylinder contains a piece of cadmium whose vapours rise into the bulb. When the discharge is not turned on, the Cd-vapour deposited is evenly distributed over the glass walls and electrodes; but irregularities in the glass, so far unsuspected, are noticed. When the discharge current is passing, the distribution of the Cd is polarised, and the irregularities just mentioned become more prominent. At very low gas pressures the vapour is deposited chiefly on and near the kathode. With increasing gas pressure this preference for the kathode increases at first and then diminishes; the differential character of the condensation is more marked in an atmosphere of hydrogen than in nitrogen and in argon. From pressures of 0·8 mm. upwards the excess condensations take place on the anode; but the gas again plays a part, so that at 1·2 mm. pressure there is an excess deposit of 28 per cent. on the kathode in hydrogen, but no excess in argon. The author no longer suggests that the gas in the bulb enters into combination with the volatilised metal. But the nature of the gas enters in two ways: the atomic rays give off more energy when of greater mass (J. Stark); and the greater the mass, the less deeply the gas atom will be able to penetrate into the metal, so that more metallic atoms are secondarily emitted. H. B.

224. *Electric Discharge in De La Rive's Tube.* **D. N. Mallik.** (Phil. Mag. 24. pp. 500–507, Oct., 1912.)—When an electric discharge is passed through a De La Rive's tube at different pressures, it is found [see Abstract No. 2007 (1908)] that there are three stages of the discharge:—(1) At a high pressure the discharge is in the form of a shower, consisting of an infinite number of rays; (2) these, gradually, as the pressure is diminished, form into a single band or stream; (3) as the pressure is further reduced, the band broadens and ultimately fills the whole tube as a glow discharge. The electric discharge is next considered as a procession of corpuscles shot off from the negative electrode under the influence of the electric field and ions, positive and negative, produced by collision of these corpuscles with the molecules of the enclosed gas. The ions and the corpuscles exert electric force on one another, and as they are in motion they exert a magnetic force

as well. Also, since these masses are moving through the fluid medium, they must exert an additional apparent force on one another, besides experiencing a viscous retardation in the direction of motion. The above lines of thought are then mathematically worked out, and it is shown that the magnetic rotation corresponds to the second (or band) stage of the discharges. Other results in accord with experiment are obtained. E. H. B.

225. *Emission of Charges in Vacuo.* **E. Henriot.** (Le Radium, 9. pp. 224–227, June, 1912.)—Two elements, K and Rb, are clearly distinguishable by a radiation analogous to that from radio-active bodies, from ordinary substances, of which the activity is doubtful. Potassium emits β-rays approximately homogeneous and easily deviable, with a penetrating power about equal to that of the β-rays from uranium; this radiation is normal, atomic, and spontaneous. Rubidium emits slower β-rays, fairly homogeneous, with a penetrating power about equal to that of β-rays from radium; general characters, like those of the rays from potassium. Potassium, rubidium, and their salts emit, spontaneously *in vacuo*, electrical charges, of which at any rate a great part must be attributed to ionising β-rays. [See also Abstract No. 1416 (1912).] A. D.

226. *Energy absorbed by Gas under Influence of Alternating Currents.* **A. Chassy.** (Journ. d. Physique, 2. Ser. 5. pp. 826–831, Oct., 1912.)—An experimental investigation of the heat absorbed by a gas at atmospheric pressure and subject to alternating currents, and in continuation of previous work [see Abstract No. 1554 (1911)]. The author concludes that in this case the energy absorbed per sec. is proportional to the charge Q at each period, and not to the square of Q as would correspond to the case for metallic conductors. E. H. B.

227. *Potential Measurements in the Neighbourhood of the Electrodes in Point-plane Discharge.* **[Miss] P. M. Borthwick.** (Phil. Mag. 24. pp. 608–618, Oct., 1912.)—Chattock and Tyndall have shown that the value of a field at the surface of a discharging point, under various conditions, can be obtained by measuring the pull of the lines of force on its end, which they made hemispherical for the purpose [see Abstract No. 1482 (1910)]. The work described in the present paper was undertaken mainly with the view of obtaining support for their results, by measurement of the potential drop in the neighbourhood of a discharging point. It is found that the potential drop in the immediate vicinity of a point discharging on to a plate is independent of (*a*) the distance between the electrodes, (*b*) the current between the electrodes. The potential drop required to start the discharge is slightly greater at a negative than at a positive point. Experiments are described showing the effects on the potential drop, of supplying to the point ions from an external source. These results are discussed in the light of previous determinations of the field at a discharging point, obtained from measurements of the mechanical pull on its surface. The potential gradient in the vicinity of the plate is also measured over certain ranges of current and distance. A. E. G.

228. *Discharge between Concentric Cylinders in Gases at Low Pressures.* **F. W. Aston.** (Roy. Soc., Proc. Ser. A. 87. pp. 428–436, Oct. 31, 1912.)—The author has previously described investigations upon the length of the

Crookes dark space and the relation between current and potential in the discharge between large plane Al electrodes in different gases at various pressures [see Abstract No. 915 (1912)]. For all the chemically active gases, and also for gases of the He group when these are not in a state of great purity, the two following equations were found to hold over a considerable range of the four variables:—

$$D = A/P + B/\sqrt{C}, \qquad V = E + F\sqrt{C}/P,$$

where D is the length of the dark space, P the pressure, V the p.d. between the electrodes, and C the current density. In the present experiments parallel plane electrodes are replaced by two in the form of concentric cylinders, and the gases used are hydrogen and oxygen. A special form and arrangement of apparatus is described. Mean values of the constants A, B, E, and F for convex, plane, and concave Al kathodes are given in oxygen and hydrogen gases. The results described show that the relations between pressure, voltage, and length of the Crookes dark space in the discharge between concentric cylinders take much the same form as those in the discharge between parallel planes. Curvature of the surface of the kathode appears to have no influence upon the rate of alteration of the length of the dark space with change of current density, so long as the latter is measured at the surface of the kathode. *Celeris paribus*, the length of the dark space is greater for a convex cylindrical surface than a plane, and for a plane than a concave one. A. E. G.

229. *Conductivity of Gases in Ring Discharge without Electrodes.* **R. Wachsmuth.** (Ann. d. Physik, 39. 3. pp. 611–624, Oct. 15, 1912.)—An historical *résumé.* The conductivity curve begins at a small pressure ($p = 0{\cdot}03$ mm.), rapidly rises to a high maximum, then falls (as pressure increases) to a relatively high minimum at $p = 0{\cdot}13$ mm.; at $p = 0{\cdot}16$ mm. luminosity ceases; thereafter the conductivity first rises to another (lower) maximum and then steadily falls (the curve being somewhat concave upwards). Traces out the modifications in the form of the curve and the relations of the phenomena of luminosity to these. The latter maximum of the conductivity curve corresponds to the intersection of the curves for saturated and for unsaturated current. Throughout the region of luminosity (from $p = 0{\cdot}16$ mm. to $p = 0{\cdot}03$ mm.) the current is saturated, and as the pressure is reduced the number of ions produced increases. A. D.

230. *Bunsen Flame as Wireless Detector.* **G. Leithäuser.** (Phys. Zeitschr. 13. pp. 892–894, Sept. 15, 1912.)—The flame of a Méker burner is used as a wireless telegraphy detector. The electrodes are a copper or Pt wire and a Pt plate covered with a potassium salt. The electrodes are from 5 to 10 mm. apart. No auxiliary e.m.f. is necessary, provided the electrodes are at different temperatures. The Pt plate must be glowing brightly. A potassium salt is found to give better results than those of Na, Li, Sr, Ba. The detector may be made nearly as sensitive as an electrolytic detector. T. P. B.

231. *Electrical Vibrations on a Thin Anchor-ring.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 87. pp. 193–202, Aug. 21, 1912.)—Mathematical.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

232. *Effect of Abrasion on the Conductivity of Selenium.* **F. C. Brown.** (Phys. Zeitschr. 13. pp. 859–864, Sept. 15, 1912.)—The author describes an effect of abrasion discovered independently by himself and by Giltay, who made the selenium preparations experimented upon. Giltay produced the abrasions by a sand-blast, whereas the author produced them by filing. Both methods led to an increase in the conductivity, accompanied, however, by a diminution of the relative sensitiveness to light. It took about a month before the Se had recovered its initial electrical condition. When about one-third of the total Se present was filed off the conductivity fell to one-twentieth of its initial value, probably owing to the conversion of a large proportion of the conducting Se into the amorphous variety. The author points out that the conductivity is also increased by pressure and by radium rays. The latter may be due to the injury of the Se surface by the impact of the rays.
E. E. F.

233. *Action of Selenium.* **A. Pochettino.** (N. Cimento, 4. Ser. 6. pp. 189–203, Sept., 1912.)—Criticises the electronic theory of the light-action of selenium advocated by Ries and Pfund. A number of transformations of one allotropic form of Se into another are accelerated by light, so that the chemical theory of the light action has an experimental basis. Among these transformations are that of amorphous Se into the grey crystalline form, the solution of Se in CS_2 and its precipitation by evaporation or from colloidal suspension, and finally the transformation of amorphous into grey crystalline Se under the action of quinoline, aniline, pyridine, and piperidine. As regards the influence of temperature, it is doubtful whether all chemical action ceases at − 185°, at which temperature Se is still light-sensitive. The author brings forward grounds for his belief that light-negative Se preparations can be obtained free from moisture, which would tell in favour of the chemical theory. He also points out that when the incident energy is great, the red rays have a greater effect for the same energy than the blue rays, which tells against the electronic theory. Finally, he maintains that the somewhat similar action of light on silver iodide, copper iodide, granular silver, antimonite, and sulphur, is best explained by a theory of chemical transformation.
E. E. F.

234. *Effect of Vibration on the Electrical Resistance of Metals.* **H. L. Brakel.** (Phys. Rev. 35. pp. 185–193, Sept., 1912.)—It has been shown that torsion and hydrostatic pressure both affect the resistance of metals [see Abstracts Nos. 491 (1909) and 441 (1911)] and the author has studied the effect of torsional vibration of various amplitudes on the resistance of a number of metals and alloys at various temperatures. Amplitudes up to 335° C. produce no measurable alteration at ordinary temperatures, but at higher amplitudes and temperatures the resistance is increased. Annealing at a bright red-heat completely removes the change brought about by vibration.
F. C. A. H. L.

235. *Resistance of Powdered Conductors.* **A. A. Somerville.** (Metallurgical and Chem. Engin. 10. p. 485, Aug., 1912.)—Powdered carbon and silicon placed in a porcelain tube into which metal rods were inserted, were successively examined as to change of electrical resistance when pressure was applied and when the temperature was changed from 20° to 1000° or 1100° C.

It was found that there was practically no change in resistance after a pressure of about 850 lbs. per sq. in. was reached. Up to that pressure the resistance decreased rapidly. At room temperature the resistance of the powdered carbon was 2·2 ohms (50 times greater than solid carbon) and of the silicon 600,000 ohms (25,000 times that of a similar piece of solid Si). The carbon resistance decreased on heating to 0·6 ohm at 1000° C., the rate of change being twice as great as for solid carbon. The decrease in resistance of the silicon was much more rapid. The variation in resistance of solid silicon is first negative, then positive, and afterwards negative again.

J. J. S.

236. *Electric Resistance of Mixtures of Copper and Mercury.* **A. P. Schleicher.** (Zeitschr. Elektrochem. 18. pp. 998–1000, Nov. 15, 1912.)—On the instigation of Guertler [see Abstract No. 1901 (1912)] the author tried imitation alloys, prepared by drawing copper wires 0·5 mm. thick axially through a glass tube, 1·8 mm. in diam., placing the tube between two mercury troughs and filling it with mercury. There were eight wires. Taking one wire out after the other, he obtained conductivity measurements for different cross-section ratios Cu/Hg, and the conductivity of the mixture proved to be a linear function of the volume concentration, as expected. The wires were then broken up into pieces of 1 cm. length; the same law still held. The attempted experiments with smaller particles, to imitate mixtures with transverse arrangements or irregular mixtures, were unsuccessful.

H. B.

237. *Influence of Pressure on the Electric Conductivity of Metallic Alloys.* **B. Beckman.** (Ark. för Mat. Astron. och Fysik, Stockholm, 7. 42. pp. 1–18, 1912.)—Following the expression for the electric conductivity worked out by P. Drude in his electron theory the author has previously sought to express the conductivity (σ) of a metallic conductor as a function of the pressure (p) by means of the equation: $\sigma = \sigma_1 e^{ap + bp^2}$, where σ_1 is the conductivity at 1 atmo. pressure and a and b are constants. The term bp^2 in the index is a correction term: in the case of most of the substances examined by the author $b = 0$. The constant a is the pressure coefficient of the specific electric conductivity. The investigation of gold-nickel alloys is described in the present paper. These two metals are in the solid condition only partially soluble in each other. Eight Au-Ni alloys have been examined. They were heated for some hours to 800° or 900° C. and drawn into wires of 0·8 mm. diam. The specific conductivity, pressure-coefficient, and temperature-coefficient were determined. The results of the observations are given in tables and curves, the percentage composition of each alloy being given. If two metals in the solid condition are only partially soluble in each other and, as in the case of the Au-Ni alloys, between two series of solid solutions a mixture interval with mean concentration exists, then the curve showing the electric conductivity as function of the volume concentration has the following appearance: Starting from the pure metal the curve quickly falls then bends a little towards the middle till it attains the concentration of the saturated solid solution. These two branches of the curve are connected by a straight-line middle portion that extends over the concentration of the mixture interval. According to Barus the following rule holds: If to a metal a small portion of another metal is added, there exists between the resistance and the temperature-coefficient α of the alloy so formed the following relation: $W = n/(\alpha + m)$; where n and m are two constants which depend

only on the peculiarities of the metal which predominates in the mass. The relation may be expressed : $\alpha = n\sigma - m$. According to W. Guertler this linear relation between α and σ is only maintained so long as the added mass of metal remains under the saturation concentration of the solid solution. The linear relation between the conductivity and pressure coefficient in the case of the Au-Ni alloys appears from one of the author's curves to hold with alloys which contain up to 11·2 volumes per cent. (16·7 atomic per cent.) of Ni. With Au-Ag alloys the pressure coefficient is a linear function of the temperature coefficient. In the case of the Au-Ag alloys the pressure coefficient can be expressed as a function of the conductivity by the relation $\alpha = \eta\sigma + \delta$, where $[\eta]_{Ag} = 4{\cdot}00 \times 10^{-12}$. For the Au-Ni alloys which contain up to 11·2 volumes per cent. the same relations hold, when $[\eta]_{Ni} = 2{\cdot}15 \times 10^{-7}$. The ratio between these two constants is: $[\eta]_{Ag}/[\eta]_{Ni}$ = (atomic weight of Ag)/(atomic weight of Ni) = 1·84. The investigations show that nickel in small amount in the solid state is soluble in gold. J. J. S.

238. *Electric Attraction between two Conducting Spheres.* **A. Guillet** and **M. Aubert.** (Comptes Rendus, 155. pp. 708–711, Oct. 14, 1912.)—The mutual action F between two spheres whose radii are a and b respectively and the distance between the centres of which is x is given by—

$$\begin{aligned} F = -(V_1^2/2) \sum_1^{\infty} a^{n+1} b^n \frac{\partial}{\partial x} \cdot \frac{1}{P_{2n}} \\ + V_1 V_2 \sum a^{n+1} b^{n+1} \frac{\partial}{\partial x} \cdot \frac{1}{P_{2n+1}} \\ - (V_2^2/2) \sum a^n b^{n+1} \frac{\partial}{\partial x} \cdot \frac{1}{Q_{2n}}, \end{aligned}$$

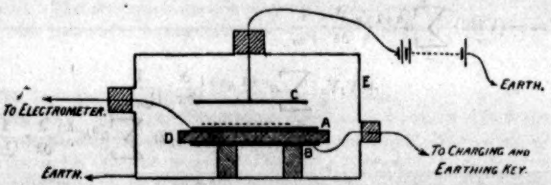
where V_1 and V_2 are the potentials of the two spheres and P and Q are polynomial expressions in x of the degree marked by the subscript and the coefficient of the first term of which is unity. The polynomials P_{2n+1} and Q_{2n+1} are identical and

$$P_{2n} = xP_{2n-1} - b^2 P_{2n-2}, \quad Q_{2n} = (1/x)(P_{2n+1} + b^2 P_{2n-1}).$$

The properties of these polynomials are investigated, and their connections with Heine's spherical functions are found. A. R.

239. *Electric Spark-gap formed by two Conducting Spheres.* **A. Guillet** and **M. Aubert.** (Comptes Rendus, 155. pp. 820–823, Oct. 28, 1912.)—One of the spheres is fixed to an insulated plate which can be moved in three directions mutually at right angles, through distances which can be accurately measured by micrometer gauges. The moving sphere is either made of aluminium and hollow or consists of a celluloid balloon, the surface of which is silvered. It is suspended by a fine thread, the other end of which is connected with the indicator. Various types are made. When the spheres are electrified certain forces are called into play. Methods of computing the charges, the potentials, and the mutual action leading to disruption are given. The computations are made by the help of the polynomials found in the previous paper. [See preceding Abstract.] A. R.

240. *Theory and Measurement of Residual Charges.* **A. Anderson** and **T. Keane.** (Phil. Mag. 24. pp. 437–445, Sept., 1912.)—The authors consider the case of a single dielectric between parallel plate electrodes in which the specific inductive capacity and specific resistance are finite and continuous functions of the distances from one of the plates. Let v be the potential of the first plate and that of the other zero. Then if r is the specific resistance and K the specific inductive capacity at a point whose distance from the first plate is x, we have $d/dx\,.\,(1/r\,.\,dv/dx) = 0$ and $d/dx\,.\,(\mathrm{K}\,.\,dv/dx) = -4\pi\rho$, where ρ is the volume density of electricity. Hence $-1/r\,.\,dv/dx$, which is the current c per unit area, is constant and the whole quantity of electricity stored in the dielectric is $(\mathrm{A}c/4\pi)\,(\mathrm{K}_0 r_0 - \mathrm{K}_1 r_1)$, where A is the area of the plates and K_1 and K_0 are the specific inductive capacities and r_1 and r_0 the resistances at the surfaces of the dielectric. Thus the amount of the residual charge, or the residual discharge depends only on the surface values of K and r (except in so far as these affect the current c). The charge Q_1 on the first plate is $\mathrm{A}c/4\pi\,.\,\mathrm{K}_1 r_1$. If q is the charge in the dielectric we have, for a homogeneous medium $q/\mathrm{Q}_1 + (r_0 - r_1)/r_1$. If this be so we must explain the existence of q by a difference between r_0 and r_1, r_0 being greater than r_1, *i.e.* the resistance of the dielectric at the kathode must be greater than at the anode. In order to show how this can be brought about by the field of force, the electron theory is made use of, the residual charge being due to changes of the surface resistances owing to a displacement of the free electrons under the action of the field of force, and it is shown that $q/\mathrm{Q}_1 = (n_1 - n_0)/n_0$, where n_1, n_0 are the numbers of the free electrons per unit volume at the anode and kathode respectively. Hence it is not necessary for a residual charge for the dielectric to be heterogeneous. To measure the residual discharge a plate of sulphur was put between two zinc plates A, B (see Fig.), the upper one, A, being connected to an electrometer. On A was placed a little uranium oxide and some distance above it was hung a third plate which could be connected to one terminal of a battery. A was first earthed and B charged to a definite voltage V for a definite time. B was then earthed and A insulated immediately afterwards by means of a special key. The electrometer will now charge up, but will be continuously discharged by the ionised air between C and A. The time required for the needle to return to resting point will measure, with a slight correction, the residual charge. The curve showing the relation between q/Q and the applied voltage approximates closely to an equilateral hyperbola. In all cases the time of charging was always greater than that required to make the residual charge closely approach its asymptotic value. It was found that no difference was produced by having plates of different metals; also the smallest electric force, if applied long enough to the dielectric, will produce some displacement of the free electrons. In the case of the particular experiment carried out it was found that at high voltages the value of n_0/n_1 becomes 19/20. The rest of the paper consists of a mathematical discussion of the problem which arises out of the experiment.



W. C. S. P.

241. *The Law of Superposition. New Experiments on Ionised Dielectrics.* **A. Zaroubine.** (Le Radium, 9. pp. 385–395, Nov., 1912.)—The author describes experiments on dielectrics ionised by Becquerel-rays. From the results obtained by passing a current through a layer of ozokerite, 2 mm. thick, ionised by rays from radium, he concludes as follows:—The ionisation current follows Ohm's law, although the e.m.f. was varied from 0 to 2000 volts. The ionisation current diminishes gradually and finally becomes zero. The shape of the current curve is hyperbolic. When a direct current traverses an ionised dielectric the law of superposition ceases to be applicable. In proportion, as the duration of the direct current increases the relative quantity of electricity transported, the inverse current of polarisation diminishes. Under the action of radium rays an e.m.f. develops in the dielectric, which produces a current analogous to that of polarisation. These results were also obtained with diphenyl. A. R.

242. *The Mutual Inductance of Coaxial Solenoids.* **G. R. Olshausen.** (Phys. Rev. 35. pp. 148–152, Aug., 1912.)—The author gives improved formulæ for calculating the mutual inductance of coaxial current sheets. He uses ϑ-function formulæ and shows by actual computation that the labour necessary is very considerably lightened. In the example considered, the current sheets are concentric as well as coaxial, and the results are given to eight significant figures. A. R.

243. *The Mutual Induction between two Parallel Coaxial Circular Currents.* **E. Mathy.** (Journ. de Physique, 2. Ser. 5. pp. 987–990, Dec., 1912.)—The author corrects the formula which he had given twelve years ago in Weierstrass' notation. Grover has recently pointed out that one of the series originally given was erroneous. He now gives the formula in terms of Gauss's hyper-geometric series. A. R.

244. *The Motion of the Needle of a Quadrant Electrometer.* **W. F. G. Swann.** (Phil. Mag. 24. pp. 445–451, Sept., 1912.)—In the measurement of small currents by observation of the rate of movement of the needle as the electricity enters one of the quadrants it is found that, owing to the inertia of the needle, the latter does not move with uniform velocity, even though the electricity passes in at a uniform rate. As considerable errors may result unless suitable precautions are taken, the author discusses the theory of the method and gives a method of avoiding the error. The equation of motion of the needle being $k\,.\,d^2\theta/dt^2 + b\,.\,d\theta/dt + a\theta = \mathrm{F}(t)$, two cases are considered, viz. (1) when the p.d. driving the electricity into the quadrant is large compared with the rise of the potential of the quadrant during the observations; (2) when the alteration in current due to the rise in potential of the quadrant is of importance. For full particulars the original should be consulted.

W. C. S. P.

245. *Photographic Recording of Ballistic and other Rapid Phenomena with the Aid of the Quenched Spark.* **C. Cranz** and **B. Glatzel.** (Deutsch. Phys. Gesell., Verh. 14. 10. pp. 525–535, May 30, 1912. Electrician, 70. pp. 958–959, Feb. 28, 1913.)—After briefly reviewing earlier methods used for the photographic recording of rapidly occurring processes, such as ballistic phenomena, the authors describe the method employed by them, which enables a regular succession of pictures to be taken of a single bullet fired from a pistol, on a falling photographic plate. A direct-current quenched gap (of the Scheller type using alcohol) is used, connected to 700-volt mains. The capacity in the gap circuit is made up of mica condensers variable from 25,000 to 600,000 cm.; the inductance is kept very small. This inductance and that of the secondary (= 1800 cm.) are in the form of flat spirals so as to secure very close coupling. In the secondary is a small spark-gap (used to illuminate the object to be photographed) shunted by a condenser. The exposures are made on a film which runs over two drums of 89 cm. circumference, capable of making a maximum of 9000 revs. per sec. It is found that the number of sparks passing can be adjusted accurately to any number between 200 and 100,000 per sec. by (1) altering the capacity in the primary circuit; (2) regulating the intensity of the current in the primary. Reproduced photographs show the capabilities of the method. With 6400 sparks per sec. the firing of a shot at a piece of wood is seen in all its phases. With 10,000 sparks per sec. the movements of the cartridge in the operation of an automatic pistol can be followed. Other records show the issuing of a bullet from the muzzle, and the accompanying phenomena, taken with spark frequencies of 56,600, 72,000, and 92,200 per sec. The possible application of the method to the investigation of electric double refraction is referred to. L. H. W.

246. *Photographic Registration of α-Particles.* **H. Geiger** and **E. Rutherford.** (Phil. Mag. 24. pp. 618–623, Oct., 1912.)—In a previous paper [Abstract No. 1627 (1908)] the authors have described an electrical method of counting the α-particles from radio-active substances, an electrometer being used to detect the entrance of an α-particle into the testing vessel. With this arrangement it was not possible to count with accuracy more than about 10 α-particles per min. Since then a string electrometer has been used, and with this apparatus 1000 α-particles per min. may be counted. It is necessary, for accurate work, that the electrometer fibre after displacement should return rapidly to its equilibrium position. This was effected by connecting the fibre through a comparatively low resistance to earth. Suitable resistances were made from capillary tubing filled with a mixture of xylol and alcohol. The large back leak thus obtained has the advantage of cutting out the great majority of slow electrical disturbances, for only rapid changes of potential make their effect visible. The detecting vessel consisted of a metallic hemisphere, near the centre of which was a spherical electrode supported by a metal rod. The α-particles entered the vessel through a small opening in the middle of the curved side covered with a thin sheet of mica. Helium at suitable pressure was introduced into the apparatus, and with this arrangement the throws were remarkably uniform, so that it was easy to recognise by the length of the throw when two or even three α-particles entered the vessel in rapid succession. The photographic registration apparatus constructed by Edelmann was found to answer very well. The speed of the film could be adjusted over a wide range according to the number of α-particles to be registered per min. Experiments are in progress to test whether an electric method can be employed to count *recoil* atoms with certainty.

A. W.

247. *A Magnetic Shunt Vibration Galvanometer.* **H. Tinsley.** (Electrician, 69. pp. 939–941, Sept. 13, 1912.)—The majority of vibration galvanometers on the market suffer from lack of stability of the coil at low frequencies. The author has evolved an instrument of the Kelvin type in which tuning is brought about by means of a magnetic shunt. He defines the ratio of the increased

sensibility of such an instrument when used with alternating current of the same periodicity as the natural frequency of the instrument, to its sensibility to direct current, as the "resonance multiple." In order to make this ratio as high as possible the molecular friction of the suspension was made as small as possible by using a fine silk fibre, and the mirror was made of an elongated shape so as to reduce the air friction. The silk fibre is kept taut by a light spring at the top, and so prevents the suspended magnet M being drawn sideways on to the poles of the controlling magnet. By means of a turning screw a magnetic shunt is made to traverse the two limbs of the permanent magnet and so vary the controlling force of the needle. The instrument gives a narrow range of resonance, a variation in frequency of 2 per cent. above or below the critical tuning at 50∿ reducing the deflection by 80%. The advantages of this instrument are : (1) interchangeable suspensions ; (2) interchangeable coils of different resistances ; (3) great stability of zero ; (4) ease of tuning without disturbing the zero. The suspension is of a shape which permits of its enclosure in glass so that at high frequencies it is possible to reduce air damping by working *in vacuo*. The disadvantages of this type of instrument are its rather long time in coming to rest (about 10 secs.), and its liability to get into resonance with stray magnetic fields of the same frequency. W. C. S. P.

248. *Electrocapillary Pulsation of a Mercury Meniscus.* **A. P. Roshdestwensky and W. C. McC. Lewis.** (Faraday Soc., Trans. 8. pp. 220–230 ; Discussion, pp. 230–231, Oct., 1912.)—Lippmann's electrocapillary measurements with sulphuric acid solution have been repeated and confirmed, using a somewhat modified form of his apparatus. No abnormal results were obtained. With other solutions—mercuric cyanide solutions—it was accidentally observed, however, that the meniscus under given conditions is not at rest, but oscillates regularly round a mean position. The occurrence of this pulsation is confined within fairly narrow limits, the determining factors being : (1) size of capillary ; (2) magnitude of e.m.f. ; (3) concentration of mercury ions. L. H. W.

249. *Hydroelectric Machines.* **A. Bernini.** (N. Cimento, 4. Ser. 6. pp. 204–206, Sept., 1912.)—A further quantitative study of hydroelectric machines and influence machines based on similar principles [see Abstract No. 1594 (1911)]. It is found that in many cases the energy of charge exceeds the energy of fall which produces the charge. This peculiarity is investigated by substituting millet seeds for drops of water. It is found that there is a certain amount of frictional electrification which accounts for the excess. E. E. F.

250. *New Absolute Electrometer.* **A. Guillet and M. Aubert.** (Journ. de Physique, 2. Ser. 5. pp. 990–1006, Dec., 1912. Paper read before the Soc. franç. de Physique, Nov. 14, 1912.)—A more complete account of the arrangement described in Abstract No. 1556 (1912).

251. *New Type of Compass Declinometer.* **R. L. Faris.** (Terrestrial Magnetism, 17. pp. 109–114, Sept., 1912.)—Illustrated.

ALTERNATING CURRENTS AND MAGNETISM.

252. *Internal Force in Ferromagnetic Bodies placed in a Magnetic Field.* **F. Piola and L. Tieri.** (Accad. Lincei, Atti, 21. pp. 335–343, Sept. 22, and

pp. 481–488, Oct. 18, 1912.)—The author proposes to measure the internal force in a ferromagnetic body placed in a magnetic field by observing the change in shape which the body undergoes when subjected to an external force. For this purpose the field must vary in such a cycle that for each of its values the previous history of the body, and hence the induction, is known. The external force applied must also be cyclic, each value corresponding to a definite deformation, and the field and external force must act simultaneously. These conditions are attained by using an alternating current of constant frequency and amplitude for the production of the field, and a second alternating current for applying the external force, the two currents acting simultaneously, and the variation of the second being adjustable so as to compensate the effects of the first. A preliminary experiment has been made on the longitudinal tension produced in a nickel wire, 0·7 mm. in diam., and 81 cm. long, placed vertically along the axis of a copper wire helix of diam. 1·4 cm., through which passed an alternating current. The upper end of the nickel wire was fixed, and the other, connected to one arm of a brass lever with a mirror attached, was prolonged in a piece of aluminium, to which was attached a large copper coil with vertical axis. The reciprocal action between this and a second copper coil, both traversed by an electric current, produced the external force, and as a result of the experiments, it is concluded that the longitudinal tension in the nickel is proportional to the square of the magnetic field in which the body is placed, which does not agree with Maxwell's theory, but is in accord with that of Kirchhoff. W. H. St.

253. *Magnetic Studies.* **S. R. Williams.** (Phys. Rev. 35. pp. 282–287, Oct., 1912.)—In the relation between the Joule magnetostrictive effect and the magnetic induction in the same specimen of steel, the author had previously pointed out that the max. elongation of the steel rod in the Joule-effect, and the knee of the induction curve occur at the same magnetic field strengths. It is suggested that both were due to one cause, which might be the behaviour of the elementary molecular magnet. A model consisting of 27 ellipsoidal elements was then built up in cubical form which showed that both the orientation and the distance apart of the elements affected the magnetic properties. [See Abstracts Nos. 790 (1911), 589 and 1110 (1912).] E. H. B.

254. *Magnetic Reaction of a Copper Disc rotating between the Poles of a Magnet.* **W. G. Cady** and **F. G. Benedict.** (Phys. Zeitschr. 13. pp. 920–930, Oct. 1, 1912. From the English.)—In measurements of the activity of a man it is customary to employ the bicycle-ergometer in which a copper disc is made to spin in a magnetic field, and the heat evolved is measured calorimetrically. The heat given out through the rotation of the pedals does not increase proportionately to the speed, but reaches a max. value and then diminishes. For the speeds generally employed in practice the heat evolved per turn can be taken as practically constant. The paper gives theoretical considerations and experimental tests in support of this statement. A. D. R.

255. *Heusler Alloys.* **F. Heusler** and **E. Take.** (Faraday Soc., Trans. 8. pp. 169–184, Oct., 1912. Phys. Zeitschr. 13. pp. 897–908, Sept. 15, 1912.)—The authors discuss in detail their hypothesis advanced in 1909 that the magnetism of the Heusler alloys is due to the occurrence of ternary chemical

compounds of Cu, Mn, and Al. These molecules, which are all supposed to be magnetic, have the general formula Al_x $(Mn, Cu)_{3x}$, where x has any of the values 1, 2, ... Granting this hypothesis they attempt to explain some of the effects observed on subjecting the bronzes to annealing and ageing processes. A. D. R.

256. *Heusler Alloys.* **A. D. Ross.** (Faraday Soc., Trans. 8. pp. 185–194, Oct., 1912.)—The author adduces magnetometric, thermometric, and metallographic evidence in support of his view that the Heusler alloys which are magnetic consist of solid solutions of varying concentration of the binary compounds Cu_3Al and Mn_3Al, and that the magnetic properties are dependent on the occurrence of such solid solutions. Details are given of the variation of magnetic properties of the alloys with the constitution and with thermal treatment, and notes are also given on the general magnetic properties of alloys of Cu + Mn + Sn, Cu + Mn + Sb, Cu + Mn + Bi, Cu + Mn, Cu + Al, Mn + Sb, Mn + B. A. D. R.

257. *Heusler Alloys.* **A. A. Knowlton** and **O. C. Clifford.** (Faraday Soc., Trans. 8. pp. 195–206, Oct., 1912.)—The authors discuss the best methods of preparing and treating the Heusler alloys so as to secure high magnetic permeability. They state that, while the hypothesis of a chemical compound [see Abstract No. 255 (1913)] is perhaps the simplest hypothesis as to the nature of these ternary alloys, their tests and the extreme variability of the alloys point to the metal being of the nature of a solid solution. A. D. R.

258. *Magnetic Properties of Nickel and Manganese Steels.* **E. Colver-Glauert** and **S. Hilpert.** (Faraday Soc., Trans. 8. pp. 134–148, Oct., 1912. Iron and Steel Inst., Journ. 86. pp. 295–301, 1912. Abstract in Electrician, 71. pp. 102–103, Oct. 25, 1912.)—A series of nickel and manganese steels was investigated with reference to the influence of thermal treatment on their magnetic and metallographic properties, and the following are among the conclusions arrived at. There is a distinct connection between thermal treatment and magnetic properties, but no definite one between metallographic structure and magnetic properties. Any modification which is produced by quenching these alloys from 1200° C. is in all cases strongly magnetic at room temperature; in the case of the 25 per cent. nickel steel, two superimposed temperature-hysteresis loops exist. Further, it is possible to define various constituents by their magnetic properties, and the metallographic structure of artificial nickel-iron alloys closely approximates that of meteoric iron. The allotropic theory of the magnetic properties of iron alloys is not upheld by the facts. G. E. A.

259. *Magnetic Properties of a Variety of Special Steels at Low Temperatures.* **J. G. Gray** and **A. D. Ross.** (Faraday Soc., Trans. 8. pp. 115–133, Oct., 1912.)—Specimens of iron, carbon steels, chrome, silicon, phosphorus and tungsten steels of given composition were tested at room temperature and at − 190° C. after normalising, annealing at 900° C., quenching at 450° C., and quenching at 900° C. respectively. The effect of cooling to the temperature of liquid air is in general to diminish the permeability for low values of the magnetising force, and to augment it for high values. A magnetisation curve for − 190° C. lies initially below and finally above the curve corresponding to room temperature. The results are given in tabular form, and, in summarising, the crossing point of the I–H curves for 15° and 190° is stated for

each variety of steel. In all cases the crossing point is higher, the greater the amount of the added element. This holds for the steels in any of the abovementioned conditions. G. E. A.

260. *Kerr Magneto-Optic Effect in Ferromagnetic Compounds.* **P. Martin.** (Ann. d. Physik, 39. 3. pp. 625–636, Oct. 15, 1912. From the Bosscha Laborat. Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 138–147, Sept. 3, 1912.)—Tests on certain manganese and iron compounds yielded the following results: (1) In MnB any rotation is less that 0·3'. (2) In Mn_4Sn the effect is small, as is to be expected from the small susceptibility. The rotation is negative and gives a decided numerical minimum in the blue part of the spectrum. (3) MnSb gives much larger negative rotations, the largest rotation in the visible spectrum being at 500 $\mu\mu$, and the minimum at about 580 $\mu\mu$. (4) MnBi gives no rotation at 468 and 617 $\mu\mu$. There is a small positive rotation in the green, and negative rotations in the blue-violet and red. (5) The curve for Fe_3C. resembles that for MnSb, the max. negative rotation being at about 450 and the minimum negative rotation at 560 $\mu\mu$. (6) The rotations for pyrrhotin were positive and showed the expected variation according to the orientation of the reflecting surface with respect to the axis. A. D. R.

261. *Kerr-Rotation for Transverse Magnetic Fields.* **L. R. Ingersoll.** (Phys. Rev. 35. pp. 312–321, Oct., 1912.)—Three types of Kerr-effect exist, corresponding to the three possible cases of magnetisation: with the lines of force normal to the reflecting surface, or lying in the surface and respectively parallel or perpendicular to the plane of incidence of the light. Only a single determination for the last case has previously been made (by Zeeman) for iron. The method used for the determination of optical constants [see Abstract No. 329 (1911)] was found to be capable of such accuracy that it seemed desirable to study the effect of various directions of magnetisation on the azimuth of the reflected light. The results for transverse or "equatorial" magnetisation were found to follow closely the predictions made by C. H. Wind in his magneto-optic theory. Light from a Nernst glower is plane-polarised and reflected from the surface under trial. It will then in general be reduced to an elliptically polarised vibration, of which the two components are taken by passage through a large double-image prism analyser. The intensity of these two components can be compared for any wave-length by a special spectrobolometric apparatus. The ratio of these two components would enable us to find at once the "azimuth of restored plane polarisation," if this state of polarisation is imagined restored by a suitable phase-change, but it is found more convenient to keep the two components of the same intensity by changing the azimuth of the incident polarised light. This azimuth of restored polarisation—the principal azimuth if the corresponding angle of incidence is the principal incidence—is then read off as the complement of the azimuth of the polarising agent. Two distinct series of observations were made. In the first case parallel light was incident on the test surface, while in the second the light converged to an image of the Nernst glower at this surface. The results were in substantial agreement. For steel and cobalt the agreement between the experimental results and those calculated from Wind's theory is very good. In the case of Ni the agreement is only qualitative. Experiments with Heusler's alloy show that magneto-optic effects, if they exist at all in this metal, are less than $\frac{1}{100}$ as large as the corresponding effects in steel. A. W.

262. *Magnetic Disturbances, Sun-spots, and Solar Corona.* **A. L. Cortie.** (Observatory, No. 453. pp. 356–357, Oct., 1912. Summary of paper read before the British Association.)—Curves for the period 1898–1911 are compared of mean daily dial-area of sun-spots, mean daily range of declination and horizontal force, and yearly numbers of great and moderate magnetic disturbances. There is general accord in the curves, but noticeable discrepancies are shown.

The monthly numbers of great and very great magnetic storms for 23 years, 1889–1911, exhibit decided maxima near the equinoxes, and at such times the direction of the sun's rotation is least inclined to the ecliptic. When the earth moves into the planes of the spot zones in mid-latitudes, great magnetic storms are more frequent. The coronal streamers are long, and are mainly confined to regions adjoining the solar equator at periods near sun-spot minima. At such periods the prominences are also fewer, and their regions fall towards the equator. The long streamers of the corona appear to be "associated with the regions of prominence activity," while the shorter plumed streamers radiate from sun-spot centres. The occurrence of magnetic storms appears to be due to the earth passing through streams of electrified particles emitted from the sun. C. P. B.

263. *Initial Susceptibilities of Nickel at Low Temperatures.* **A. Perrier** and **H. Kamerlingh Onnes.** (Archives des Sciences, 34. pp. 522–534, Dec., 1912.)—The full paper corresponding to Abstract No. 750 (1912).

264. *Magnetic Determinations and Chart Corrections obtained by the "Carnegie" from Batavia to Manila and thence to Suva, Fiji,* 1911–1912. **L. A. Bauer** and **W. J. Peters.** (Terrestrial Magnetism, 17. pp. 141–144, Sept., 1912.)

RADIOLOGY AND ELECTROPHYSIOLOGY.

265. *Opacity to X-Rays of Fabrics suitably Impregnated with Lead Salts.* **L. G. Droit.** (Comptes Rendus, 155. pp. 706–708, Oct. 14, 1912.)—In order to improve the means of protecting operators habitually working with X-rays, the author makes use of the property exhibited by silk of absorbing considerable proportions of metallic salts. He has obtained a silk-waste fabric containing 68 per cent. of mineral matter consisting of lead phosphostannate: phosphoric acid, 8; tin oxide, 24; lead oxide, 34; lime, soda, etc., 2 per cent. on the weight of the fabric. Six thicknesses of this fabric form a very effective protection and are at the same time extremely supple. T. H. P.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

266. *Crystal Space Lattices.* **A. E. H. Tutton.** (Nature, 90. pp. 306–309, Nov. 14, 1912.)—Describes diffraction patterns produced by Röntgen-rays passing through zinc-blende, obtained by M. Lune at Munich, and fully published in July, 1912 (K. Bayer. Akad. München, Ber. p. 303, June 8, and p. 363, July 6, 1912). Out of an excellent crystal of zinc-blende a plate was cut 1 cm. square and ½ mm. thick, parallel to a cube face, and perpendicular to a tetragonal axis of symmetry. A beam of X-rays 1 mm. in diam. impinged normally upon it, after passing through screens to eliminate secondary radiations, the last screen being a plate of lead 1 cm. thick pierced with a hole 0·75 mm. in diam. After traversing the zinc-blende plate, the beam was received on a photographic plate. The exposure varied from 1 to 20 hours. The result shows a central dark circle surrounded symmetrically by 16 smaller black spots of elliptical shape, about 2 mm. long, arranged in a square. A fainter square appears within the intense square, and others outside. These patterns correspond to the holohedral or full symmetry of the cubic system, and show that it is the space lattice (Raumgitter) of the crystal itself which produces the pattern. **W. H. Bragg.** (Ibid. pp. 360–361, Nov. 28, 1912.)—Bragg replies to the above. Any plane within a crystal which is "rich" in atoms may be regarded as a reflecting plane, and the position of the spots can be calculated from the laws of reflection. E. E. F.

267. *Absorption of Helium and other Gases under Electric Discharge.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 87. pp. 381–384, Oct. 2, 1912.)—Berthelot announced in 1896 that argon and helium, when submitted to the silent discharge in the presence of benzene or carbon disulphide, were absorbed by these substances and could afterwards be extracted from the solid substances deposited on the walls of the vessel. The author repeated the experiment with helium in a Siemens tube containing mercury, a layer of CS_2 floating on it, and helium. The silent discharge continued for 120 hours produced no contraction of volume; a solid deposit was formed, but it yielded no He when heated. In a test experiment nitrogen was absorbed under similar conditions. In other experiments (bulbs with Al-wire electrodes) nitrogen was absorbed by phosphorus (which is converted into red phosphorus by the silent discharge) and not liberated again when the red phosphorus deposited on the walls was afterwards heated. Hydrogen was also absorbed and not reliberated by heating. In the case of helium a slight absorption was observed and the gas liberated again by heating, so that the absorption by phosphorus appeared to be mechanical in the case of He, but chemical in the case of H and N. H. B.

268. *Theory of the Solid State.* **E. Grüneisen.** (Ann. d. Physik, 39. 2. pp. 257–306, Sept. 24, 1912.)—Bases a fuller theory of the solid state of monatomic elements upon the data accumulated by the Reichsanstalt. The method adopted is based upon that of Mie [Abstract No. 1450 (1904)], who assumes both attractive and repulsive forces between the atoms, the latter diminishing more rapidly than the former as the distance increases. Among the matters dealt with are the change of atomic frequency with temperature

and pressure; heat of sublimation at the absolute zero; expansion and amplitude of oscillation; frequency, melting-point, and compressibility; and latent heat of fusion. Some of the results arrived at are the following:—The relative expansion between absolute zero and melting-point is approximately the same for all monatomic elements. The ratio of the mean amplitude to the mean distance of adjacent atoms increases with the temperature in nearly the same manner as the square root of the volume expansion. With the same expansion, the amplitude is nearly the same fraction of the atomic distance. Hence, at their fusing-points, the ratio of the mean amplitude to the mean atomic distance is nearly the same for all monatomic solids. E. E. F.

269. *Unusual Case of Specific Gravity.* **A. L. Hyde.** (Amer. Chem. Soc., Journ. 34. pp. 1507–1509, Nov., 1912.)—When *p*-nitrotoluene is dissolved in carbon disulphide, the specific gravity of the solution is less than that of either the solvent or solute. The decrease in the sp. gr. is nearly proportional to the percentage of *p*-nitrotoluene in the solution, the relation being expressed by the formula $D = 1{\cdot}2660 - 0{\cdot}0013a$, where a is the percentage of *p*-nitrotoluene present. Further experiments showed that both carbon disulphide and *p*-nitrotoluene always tend to increase the volume of solutions into which they enter, although the specific gravity of the solution is not in all cases less than that of the pure solvent. *o*-Nitrotoluene seems to have a similar effect. T. S. P.

270. *Molecular Statistics of some Chemical Actions.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 87. pp. 302–309, Oct. 2, 1912.)—When a gas is absorbed or chemically acted on by a solid surface, the rate at which the change proceeds must depend on the number of collisions made by the gas molecules with the surface, and the question as to the number of such collisions which are required for the achievement of a successful result has been examined in the case of the action of ozone on silver and of active nitrogen on copper oxide. In the ozone experiments a stream of air was made to pass through a discharge tube, in which the air becomes charged with ozone and nitric oxide. By causing the gases to pass through a silver gauze partition, the ozone is destroyed and the glow ceases. The minimum area of silver surface which suffices to produce this result has been determined, and the data show that less than 1·6 collisions with the silver surface suffice to destroy a molecule of ozone. This result points to the conclusion that one collision with a silver surface is sufficient to destroy an ozone molecule. Similar experiments with active nitrogen and copper oxide gave 780 as an upper limiting value for the number of collisions which occur before a molecule of active nitrogen is destroyed by a surface of oxidised copper. The data obtained by Jones and Chapman for the rate of decomposition of ozone in the absence of surface effects have also been examined statistically, and the author calculates that at 100° C. two molecules of ozone must, on the average, collide 6×10^{11} times before the favourable type of collision occurs which results in chemical decomposition. T. S. P.

271. *Nature of Chemical Action produced by α-Particles.* **S. C. Lind.** (Journ. Phys. Chem. 16. pp. 564–613, Oct., 1912. Le Radium, 9. pp. 426–431, Dec., 1912.)—Previous experiments by the author have shown that when α-particles pass through oxygen the number of molecules of ozone formed is equal to the number of ions produced by the α-particles [Abstract No. 1288 (1912)]. The various available data on chemical effects under radio-active influences including experiments of Cameron and Ramsay, Debierne, Usher, and of the author have now been examined, and in all cases the number of molecules undergoing reaction is found to be little different from the number of ions produced. The list of reactions that have been studied include reactions of combination and of decomposition; reactions proceeding with, as well as opposed to, the chemical free energy; even reactions in liquid systems and solutions obey the same principle. In the various experiments it is necessary to take into account all the conditions regarding pressure, length of path of the α-particles, etc., and formulæ are deduced for the calculations with different-sized vessels, etc. The results show that there is no experimental evidence that the action of the β-rays ever exceeds the subordinate proportion that corresponds to the relative amount of ionisation produced by them as compared with that by α-particles. E. M.

272. *New Modification of Sulphur.* **A. H. W. Aten.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 572–583, Nov. 28, 1912.)—If a solution of rhombic sulphur in sulphur chloride, saturated at the ordinary temperature, is heated at about 170° and then cooled, it is found that a further and considerable quantity of sulphur may be dissolved in the liquid. It is shown that this cannot be due to the formation of $S\mu$ from $S\lambda$, for the solubility of $S\mu$ in sulphur chloride is very small at the ordinary temperature, and if solutions saturated with $S\mu$ at a higher temperature are cooled down, this separates out quite readily. Systematic determinations of the solubility of rhombic sulphur in sulphur chloride which has been heated with varying proportions of sulphur at a definite temperature and then cooled to either 25°, 0°, or —60°, give data which point to the formation of a new variety of sulphur. If this conclusion is correct, it should be possible to obtain some information in the absence of sulphur chloride. This is actually the case, for if sulphur is heated alone to 125° and rapidly cooled, and its solubility in sulphur chloride examined, it is found that the solubility is distinctly greater than that of the unheated rhombic sulphur. T. S. P.

273. *Relation between the Sulphur Modifications.* **H. L. de Leeuw.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 584–593, Nov. 28, 1912.) —If the sulphur contained in a dilatometer tube is heated to its boiling-point, and then rapidly cooled so that a large proportion of the $S\mu$ formed remains intact, it is found that the temperature of conversion of rhombic into monoclinic sulphur is lowered from 95·45° to about 71°. As the proportion of $S\mu$ present decreases, the transition temperature rises until it reaches 95·45°, which must be regarded as the true unary transition point. Kruyt's work [Zeitsch. Elektrochem. 10. p. 581, 1912] on the dynamic allotropy of sulphur is criticised adversely, and it is shown that there is no evidence for the assumption of a region of partial miscibility in the liquid phase. The occurrence of two liquid layers is due to differences in temperature, and when the thermal conductivity is increased by the introduction of Pt wire or gauze, the phenomenon in question is only observed very indistinctly or not at all.

T. S. P.

274. *Limit of Formation of Endothermic Compounds at very high Temperatures.* **E. Briner.** (Comptes Rendus, 155. pp. 1149–1151, Dec. 2, 1912.)—According to the principles of chemical equilibria, endothermic compounds become more stable with rise in temperature. It follows that compounds such as the oxides of nitrogen, ozone, carbon disulphide, etc., should exist in

greater and greater concentrations as the temperature rises. This, however, would contradict the results of spectrum analysis, which proves the elementary nature of substances existing in the hottest stars. The contradiction is done away with when the dissociation of the molecules of elementary substances into their atoms at high temperatures is taken into account. Taking the values for the heat of formation of molecules from atoms as found for various elements by different observers, the author shows that compounds said to be endothermic become exothermic at temperatures sufficiently elevated, and their concentration reaches a maximum and diminishes with further rise in temperature. Taking the case of nitric oxide, and applying van t'Hoff's equation, $(d \log_e \mathrm{K})(d\mathrm{T}) = -\mathrm{Q}/(\mathrm{RT}^2)$, it is shown that when the temperature is sufficiently high for the molecules of oxygen and nitrogen to be completely dissociated, the concentration of the nitric oxide will diminish with rise in temperature. T. S. P.

275. *Influence of Oxygen on the Properties of Metals and Alloys.* **E. F. Law.** (Inst. of Metals, Journ. 8. pp. 222–230; Discussion and Correspondence, pp. 231–247, 1912. Engineering, 94. pp. 439–441, Sept. 27; Discussion, p. 448, Oct. 4, 1912.)—Draws attention to the great influence exerted by oxygen when present in metals and alloys. Although recognised by practical men, the scientific side of this question has been neglected. It is pointed out that a chemical analysis of copper which failed to report 0·1 per cent. of lead would be considered unsatisfactory, yet it frequently happens that 10 times this quantity of cuprous oxide is not reported. This omission is more serious than it appears at first sight, because the oxides, having lower specific gravities than the metals, occupy a larger volume and the influence exerted by an impurity depends upon its volume and not upon its weight. From cases examined, it would appear that metallic oxides are insoluble or practically insoluble in metals and alloys and occur as particles varying in size and distribution, entangled and embedded in the metal. Photomicrographs are given illustrating the presence of oxides in bearing bronze, arsenical copper from a locomotive fire-box, and also a series to show the effect of increasing additions of arsenic to oxidised copper. As regards the effect of the presence of oxides on mechanical tests, the minimum effect is produced when the oxide occurs in the massive form and the max. effect when the oxide occurs as a network between the crystals. Abnormal corrosion of metals, as also pitting and local deterioration, etc., is in most cases due to the presence of non-metallic impurities, and in all investigations of corrosion the presence of oxides must be taken into account. C. O. B.

276. *Alloys of Aluminium and Zinc.* **W. Rosenhain** and **S. L. Archbutt.** (Inst. Mech. Engin., Proc. No. 2. pp. 319–441; Appendix and Discussion, pp. 441–515, April–May, 1912. Tenth Report to the Alloys Research Committee. Engineering, 93. pp. 578–579; Discussion, pp. 547–548, April 26, and pp. 615–618, May 10, 1912. Abstract. Mech. Eng. 29. pp. 487–490, April 19, 1912. Summary.)—These alloys have been investigated on the general lines of the Eighth and Ninth Reports [Abstract Nos. 1711 (1907), 1540 (1910)] and their constitution has already been described [Abstract No. 1611 (1911)]. The alloys are easy to cast, machine easily, and those containing in the region of 25 % Zn have a remarkable ring when struck. In discussing the results of tensile tests the authors have introduced

the quantity "specific tenacity," which is obtained by dividing the ultimate strength in tons per sq. in. by the weight of a cubic inch in lbs., to allow of correct comparisons between the strength of materials of widely different specific gravities. Tensile tests of both sand and chill castings reveal maxima at 50 and 75 % Zn, the latter corresponding to the compound Al_2Zn_3. The highest stresses are 18·9 tons in the 75 % sand casting and 21·6 tons in the 50 % chill castings. Yield-points are very uncertain. Ageing tests carried on over 16 months showed no tendency towards loss of strength. The behaviour of the alloys under compression is similar to that under tension, but the chill castings are decidedly inferior to sand castings below 50 % Zn. Microstructures indicated an early tendency towards a cored formation which was observed at 5 % Zn in the chilled alloys. The rapid increase of the strength of zinc by the addition of small quantities of Al is explained by the early formation of the hard and strong Al_2Zn_3. Hot rolling was not found possible on alloys containing over 26 % Zn. On rolling into sheets 0·07 in. thick the alloys up to 15 % Zn behaved well, but the 20 % alloy developed cracks at the edges. All the rolled and cold-drawn alloys possessed yield-points almost as well defined as that of steel. A remarkable fact is that in alloys containing over 17 % Zn, work beyond that required for rolling down from 3-in. billets to 1¼-in. bars actually reduces the ultimate stress, while the yield stress is increased. The best mechanical tests are given by the 26 % Zn alloy in the form of a 1¼-in. hot-rolled bar, which showed a yield stress of 25 tons, an ultimate stress of 27·09 tons per sq. in. and an elongation of 25 %. The beneficial effects of work persisted after annealing, and microscopic examination indicates that the tensile strength of annealed material is not strictly proportional to crystal size, but is proportional to the severity of working. Tests made at high temperatures indicate a rapid loss of strength with increase of temperature, but the rate of loss diminishes with increasing zinc-content. Although an alloy containing 20 % Zn shows an elongation of 130 % at 595° C., forging tests above 500° C. show an entire lack of malleability and the existence of extreme brittleness under shock. Elastic tests give a modulus of 9×6^6 lbs. for the alloys. Under torsion the 20 % Zn alloy shows a max. strength of 20 tons with an angle of twist of 310°. Under dynamic stresses the alloys containing 20–25 % Zn behave remarkably well, showing a range of stress of about 12 tons under Stanton's alternating stress test. The energy absorbed in fracture under the Izod test is about 5·8 lbs. for the 20 % alloy. Comparison of the various dynamic and static tests indicates that while strength is the determining factor in Stanton's test, ductility is the most important factor in Arnold's test, and the Izod test gives a curve representing the sum of strength and elongation. The results of all the mechanical tests indicate that the best combination of properties is to be found in the 20 % Zn alloy. Corrosion tests in the sea for a period of over 500 days indicate that the corrodibility of the alloys varies from 1⅓ times that of Naval brass to 1½ times that of Muntz metal according to the zinc-content, with increase of which the rate of corrosion increases. A ternary alloy containing 25 % Zn, 3 % Cu, and 72 % Al has also been studied. Although somewhat sensitive to rolling temperatures, this gives remarkable static and dynamic tests when properly treated. Hot-rolled material shows a yield stress of 22 tons per sq. in., an ultimate stress of 28–31 tons per sq. in., and an elongation of 16·5 %. In the *discussion*, **Donaldson** confirmed the deleterious effect of excessive working. **Archbutt** quoted tests which showed that alloys made from pure Zn are decidedly superior to those made from spelter, both as regards strength and ductility. The coefficient of expansion of the 20 % alloy is 0·0000234, a value which is about double that of steel. F. C. A. H. L.

277. *Method of Producing Sound Ingots.* **R. Hadfield.** (Iron and Steel Inst., Journ. 86. pp. 11–39 ; Discussion and Correspondence, pp. 48–77, 1912. Engineering, 94. pp. 477–483, Oct. 4, 1912.)—By soundness in ingots is meant freedom from piping, blowholes, and segregation, and experience teaches that as a rule the means of removing one defect tends to diminish the others. The various methods of fluid compression are all more or less successful, but require costly apparatus. In the author's method the steel is poured into a mould, preferably small end downwards, and immediately covered with a layer of slag ½ in. in thickness. Charcoal is then placed on the slag and burnt by means of jets of compressed air. In this way the top of the ingot is kept fluid, and solidification takes place from the bottom upwards. The paper is illustrated by numerous diagrams and photographs of ingots and the rails rolled therefrom, showing that with the exception of only about 8 per cent. waste, the whole of the ingot is free from piping and segregation, so that 92 per cent. of the metal poured into the mould can be utilised, thus effecting a saving of 8s. to 12s. per ton. F. C. A. H. L.

278. *New Method of revealing Segregation in Steel Ingots.* **R. Hadfield.** (Iron and Steel Inst., Journ. 86. pp. 40–47 ; Discussion and Correspondence, pp. 48–77, 1912. Engineering, 94. pp. 484–485, Oct. 4, 1912.)—The method consists of pouring a small quantity of molten copper on to the top of the ingot soon after pouring. If the copper is added before solidification is complete it displaces the residual molten steel, but if added after complete solidification it fills up the cavities and indicates the areas of segregation. The method appears to open up a valuable source of information on the rates of cooling, segregation, and liquation, and the present results indicate that the interior of an ingot remains hotter for a much longer period than has previously been thought, thus providing greater opportunities for segregation to take place. F. C. A. H. L.

279. *Use of Thermit for obtaining Sound Steel Ingots.* **H. Goldschmidt.** (Iron and Steel Inst., Journ. 86. pp. 78–87 ; Discussion and Correspondence, pp. 88–90, 1912. Engineering, 94. pp. 485–486, Oct. 4, 1912.)—The method formerly adopted of pushing a thermit cartridge through the crust and into the pipe of a partially solidified ingot in order to melt the surrounding metal, did not have the desired effect. Latterly, however, the cartridge has been pushed right down to the bottom of the ingot before solidification commenced. The vigorous reaction which sets in immediately brings about an energetic agitation of the contents of the mould, expelling the liberated gases and driving the segregate upward. After the reaction has subsided, considerable subsidence of the metal takes place, which is followed up by pouring in fresh metal from the ladle. The new method has proved very efficacious, especially in the case of non-siliconised steel. A saving of 1s. 6d. per ton is effected on the rolled material, which also possesses the great advantage over untreated steel of showing greater uniformity in mechanical properties. F. C. A. H. L.

280. *Pre-rolled Pipeless Ingots.* **B. Talbot.** (Eng. News, 68. pp. 957–958 ; Discussion, pp. 958–959, Nov. 21, 1912.)—The author describes

a new process for the prevention of segregation and piping in ingots. Aluminium is added to the fluid steel (2 oz. per ton) to prevent the formation of external cavities and the resulting ingot is reduced about 25 per cent. by rolling before complete solidification. The partially reduced ingot is then allowed to completely solidify in a soaking pit before rolling is completed. In steel treated in this way the segregated area is confined to an annular ring between the centre and the outside, these being quite normal in composition, except that the carbon is somewhat low in the central portion, which appears to be an ideal condition for the production of rails. In the *discussion*, **Webster, Stevenson,** and **Kenney** pointed out the difficulties arising from rolling ingots at too high a temperature; these include internal rupture, the development of cross cracks, and squirting out of the metal. F. C. A. H. L.

281. *Measurements and Relations of Hardness and Depth of Carbonisation in Case-hardened Steel.* **M. A. Ammon.** (Amer. Inst. Mining Engin., Bull. 70. pp. 1167–1179, Oct., 1912.)—Samples of low-carbon and case-hardening nickel steel (3·30 per cent. Ni) were carbonised at 1650° and 1750° F. for various times. Subsequently specimens were quenched in various ways, after which the depth of carbonisation was determined microscopically and the hardness by both Shore and Brinell methods. In the Brinell method a 0·25-in. diam. ball was used under a load of 5000 lbs. The hardness number was calculated from the formula $B = 44700/D$, where B is the standard Brinell number and D the depth of penetration in ten-thousandths of an inch. The results show that the rate of carbonisation is about 1¼ times as fast at the higher as at the lower temperature, and about 1·1 times as fast in ordinary case-hardening steel as in Ni steel. In the quenched specimens the scleroscope hardness shows a gradual decrease with increasing depth of case, owing to the increase of the amount of austenite in the surface. The Brinell figures are somewhat irregular, but show a general increase up to a carbonising period of 4 to 6 hours, after which the hardness is stationary. This is in accordance with the fact that the scleroscope gives surface hardness, while the Brinell figure depends upon the condition of the core. When double quenching is adopted, the Brinell hardness after the second or low-temperature quench is always less than the figure obtained after the first or high-temperature quench for small depths of case. As the depth of case increases, the core has less and less influence on the determination of the hardness, whose value then rises until it is the same after the second as after the first quenching. This occurs at a depth of case of about 0·11 in., thus providing a method of estimating the depth of the case. F. C. A. H. L.

282. *Iron-Carbon and Iron-Silicon Alloys.* **E. Gumlich** and **P. Goerens.** (Faraday Soc., Trans. 8. pp. 98–114, Oct., 1912. Communication from the Physikal-Techn. Reichsanstalt.)—An extensive series of tests has shown that the presence of large amounts of silicon prevents, even with rather quick cooling, the formation of the extremely injurious solid solution of carbon and iron: the carbon appears only in the shape of the much less injurious pearlite. Under the influence of the Si, even the pearlite is decomposed by a prolonged process of annealing into ferrite and temper-carbon, and thus becomes magnetically almost entirely passive. To produce this effect with certainty at least from 3 to 4 per cent. of Si is necessary in the material. The fact that thin sheet-metal containing carbon and less than 3 per cent. of Si may show exceedingly good magnetic properties must have other reasons. A. D. R.

283. *Iron and Nitrogen.* **J. H. Andrew.** (Iron and Steel Inst., Journ. 86. pp. 210–226; Correspondence, pp. 227–235, 1912. Abstracts in Engineer, 114. p. 424, Oct. 18, 1912. Engineering, 94. pp. 860–862, Dec. 20, 1912.)—The author has designed a high-pressure electric furnace capable of melting iron and of withstanding pressure up to 1000 atmos. It was shown that iron and iron-carbon alloys absorb small quantities of nitrogen when melted in the gas under high pressure. The presence of 0·3 % nitrogen in pure iron entirely suppresses the critical changes, while 0·25 % in 0·6 % carbon steel causes a marked lowering of the Ar_1 point. Prolonged heating *in vacuo* is required to remove the nitrogen. The author is of opinion that the critical changes occurring in iron are due to the coalescence of like molecules brought about by contraction during cooling. The intervention of nitride of iron hinders this coalescence, with the result that a greater contraction is required before the molecules are brought sufficiently close for the molecular attractions to exert themselves. Hydrogen has no effect on the critical changes.

F. C. A. H. L.

284. *Coarse Crystallisation Produced by Annealing Low-Carbon Steel.* **R. H. Sherry.** (Metallurgical and Chem. Engin. 10. pp. 666–667, Oct., 1912.)—The production of large crystalline grains in low-carbon steels by annealing at 650° to 690° C. is often observed in the manufacture of sheets and plates, but efforts to produce the structure at will in the laboratory are not invariably successful. Experiments made by the author confirm some of the earlier observations of Stead and Charpy. Steels containing 0·07 to 0·11 % C, 0·0 to 0·075 % Si, 0·02 to 0·04 % S, 0·008 to 0·05 P and 0·05 % Mn were annealed for periods up to 48 hours. It was necessary to heat for 45 mins. to obtain the growth, but the increase was not continuous with the time. Hammered pieces showed no tendency to crystalline growth on subsequent annealing at 700° C. if the hammering was stopped just above 700° C., but if continued below 700° C., crystalline growth took place on subsequent annealing. Cold-worked material also showed a tendency to grow if the work done was light. If the reduction had been 9 to 7 per cent. crystalline growth took place at 690 to 775° C., but if over 9 per cent. reduction had been effected, growth occurred between 650° and 875° C. on re-annealing. The max. growth observed was from 0·02 to 0·8 mm. diam. of grain. F. C. A. H. L.

285. *Generation of Large Grains in Metals.* **F. Robin.** (Comptes Rendus, 155. pp. 716–718, Oct. 14, 1912.)—Stead and Charpy showed long ago that the annealing of mechanically hardened steel results in the development of very large grains making the metal fragile. Recent studies have shown this to be the case with other metals. In the area affected by a local deformation the max. growth of the grains is prevented by mutual interference, but on the borders of the area considerable growth takes place and the grains extend into the unaffected parts. The temperature and duration of the preliminary annealing and the size of the grains obtained thereby do not appear to influence the final results. Extension of the large grains into the undeformed parts from a centre of deformation caused by punching, shearing, bending, etc., follows the ordinary annealing laws. Maximum growth takes place at a certain temperature which differs for each particular metal. The author has determined the max. growth and distance of propagation of the grains of Sn, Pb, Zn, Al, Cu, and Fe, and quotes actual measurements; the results being of technical importance because of the large number of

objects made from sheet metals by cold working and annealing. Evil effects can be overcome by a final heating to above 900° C. in the case of iron and the addition of foreign elements to the other metals. F. C. A. H. L.

286. *Case-carbonising.* **M. T. Lothrop.** (Amer. Soc. Mech. Engin., Journ. 34. pp. 1997–2070, Dec., 1912.)—Elaborate experiments have been carried out to determine the effects of temperature, time, and composition of steel on the depth, rate, and nature of carbonisation and the effect of heat-treatment on the finished product. Mild steels, nickel steels, chrome-nickel, and chrome-vanadium steels were used in the tests, and the physical properties were determined by placing a bar 12 in. long and ½ in. diam. on 10-in. centres, loading at the centre, and observing the load and deflection at rupture. Strength and toughness decrease with increasing depth of case, and there is a critical depth of case for max. brittleness and minimum strength, which depth depends upon the original carbon-content of the steel. The higher the original carbon-content of the steel, the smaller the ratio of depth of case to diam. of core at the point where this brittleness occurs. Double heat-treatment increases both strength and toughness, which is also increased by subsequent tempering at 380° F. Annealing after carbonising is not to be recommended, as it does not improve the properties to anything like the same extent as double quenching, and, further, there is a distinct danger of decarbonisation. Carbonised steel becomes file-hard at temperatures too low for the development of max. strength and properties. The ideal treatment is to carbonise to the thinnest possible case demanded by the conditions, reheat for core 1600° F., quench, reheat to 1500° F. for case, quench in water or oil, and finally temper as far as conditions of service permit. Chrome-vanadium steel does not lose its file-hardness until a temperature of 450° F. has been reached, while the other steels mentioned can be softened at 425° F. Gears treated in this way can be made harder, stronger, and tougher than oil-hardened gears. With increase of temperature both the depth of carbonisation in a given time and the carbon-content of the case increase. Uniform penetration cannot be obtained below 1500° F. Nickel steel gives the greatest total penetration and gradation zones, while chrome-vanadium steels give the highest carbon maximum and the finest-grained steel. The original carbon-content does not affect either the depth of case or the amount of carbon introduced by the carbonising agent. Below 1400° F. the carbon maximum does not exceed the eutectic, but as the temperature rises a hyper-eutectic zone is formed which increases in depth with the temperature. A surface content of over 1 per cent. carbon results in the existence of films of carbide existing between the grains and gives rise to flaking. On the other hand the case does not develop its max. hardness below 0·9 per cent. carbon. In pieces to remain unground, therefore, practice should aim at a 0·9 per cent. carbon surface, but in specimens which are to be ground the surface content should be somewhat higher. An important factor in determining the temperature of carbonising is the grain-growth under the influence of heat, which is not affected by the presence of nickel but is seriously diminished in rate by the presence of Cr and V. Experiments were also made to determine the efficiency of 14 carbonising materials bought in the open market, and the results show that there is a considerable variation in the density of such materials. All of them shrink and become less potent on use. The ideal carbonising material, which should show large volume per ton, small shrinkage per run, high resistivity to change of shape or powdering, cleanliness and freedom from dust, uniform carbonising power, and capability of being used an innumerable number of times, is yet to be found. Generally speaking the thermal conductivity of carbonising materials increases with use. Copper-plating can prevent carbonisation, but the thickness of deposit must be at least 0·0005 in. to be effective. Microscopic examination of all the samples was made, and the results show that the effect of double quenching is to refine the martensitic structure of the material. F. C. A. H. L.

287. *Solubility of Metallic Oxides and Sulphides in fused Sodium Chloride.* **H. Houben.** (Metallurgie, 9. pp. 592–600, Sept. 18, 1912.)—The sodium chloride from Stassfurt, containing 98 per cent. of NaCl, was fused in Morgan clay crucibles; ordinary clay crucibles and carbon and graphite vessels proved unsuitable. The fused salt began to solidify at 820 ± 8° C., which agrees with Ruff and Plato. The experiments were made in kryptol or, better, in Helberger furnaces, the metal compound being added to 40 gm. of NaCl, of which considerable quantities evaporated, especially above 1000°, when dense white vapours escaped. Of the compounds tried, SnO_2, ZnO, PbO, CuO, ZnS, PbS, Cu_2S, only small quantities (in no case as much as 1 per cent.) were dissolved by sodium chloride, which cannot therefore be recommended as a solvent for electrometallurgical purposes. H. B.

288. *Electrical Conductance of Solutions in Methylamine and Ethylamine; Fluidity of Ammonia, Methylamine, and SO_2 and Fluidity of certain Solutions in these Solvents.* **F. F. Fitzgerald.** (Journ. Phys. Chem. 16. pp. 621–661, Nov., 1912.)—The abnormal conductivity-dilution curves given by solutions in methylamine and ethylamine have been further investigated, together with the viscosities and densities of the solvents ammonia, methylamine, and SO_2 and a number of their solutions. Solutions of silver nitrate and potassium iodide in methylamine at −33·5°, −15°, 0°, and +15° have a max. molecular conductivity at about normal concentration, followed by a minimum at $n/40$, and then a progressive rise on further dilution. There is no evidence that the molecular conductivity tends to approach a max. value at high dilutions as in the case of aqueous solvents of these substances. The results obtained with a number of other inorganic salts are similar in character. In ethylamine as solvent, solutions of silver nitrate, ethylammonium chloride, and lithium chloride show only the max. conductivity at about normal concentration. The molecular conductivity shows no tendency to increase again, after attaining a minimum, even at high dilutions. The temperature-coefficient of conductivity of solutions in methylamine and ethylamine changes sign on passing from concentrated to dilute solutions, as is the case also with certain solutions in sulphur dioxide and ammonia. The solvent and ionising properties of the amines are related to those of ammonia as the properties of the alcohols to those of water. On ascending the homologous series of solvents the ionising power and the solvent action on metallic salts decreases, but the solvent action on carbon compounds increases. The viscosities of the solutions measured decrease progressively on dilution. The viscosities, η, of the pure solvents methylamine, ammonia, and sulphur dioxide were measured. The values of the product $\eta\Lambda_\infty$, where Λ_∞ is the molecular conductivity of potassium iodide at infinite dilution, lie between 0·9 and 1·1 with ammonia and SO_2, whereas with normal solvents Walden obtained the value 0·65. Ammonia and SO_2 must therefore be regarded as abnormal in the same sense as water is abnormal. T. S. P.

289. *Conductivity, Temperature-Coefficients of Conductivity, and Dissociation of Certain Electrolytes in Aqueous Solution at 35°, 50°, and 65°.* **S. F. Howard**

and **H. C. Jones.** (Amer. Chem. Journ. 48. pp. 500–536, Dec., 1912.)—In continuation of earlier work on the same subject [see Abstracts Nos. 1745 (1911), 102 (1912)] the molecular conductivities of the following salts and acids have been measured, and the temperature coefficients and percentage dissociation calculated: Sodium ferrocyanide, potassium carbonate, potassium permanganate, dipotassium hydrogen phosphate, potassium sodium sulphate, potassium chromium sulphate (violet and green), potassium nickel sulphate, ammonium chromium sulphate (violet and green), calcium bromide, calcium chromate, zinc nitrate, zinc acetate, lead chloride, lead acetate, nickel acetate, uranyl chloride, nitrate, sulphate and acetate, hydrochloric acid, nitric acid, and sulphuric acid. Double salts in general have smaller conductivities than the sum of the conductivities of the constituent salts. These differences are little affected by temperature but become less with greater dilution. Certain discrepancies occur between the results published in this paper and those of other workers, as, for example, in the case of the alums and of dipotassium hydrogen phosphate. These are due to the fact that the hydrolysis varies with the time; the time factor is greater for concentrated than for dilute solutions, and is very little affected by the temperature. The discrepancies may also be due to decomposition occurring, with the formation of new substances. The observation is confirmed that salts with large amounts of water of crystallisation possess large temperature-coefficients. For salts which do not undergo hydrolysis the temperature-coefficient increases with the dilution. The violet forms of ammonium and potassium chrome alum have smaller conductivities than the green forms, but the differences become less at higher temperatures. With the exception of uranyl acetate and dipotassium hydrogen phosphate there was a decrease in the percentage dissociation with rise in temperature. After standing for four weeks the phosphate acted normally. T. S. P.

290. *Molecular Association in Gases.* **J. de Boissoudy.** (Comptes Rendus, 155. pp. 704–706, Oct. 14, 1912.)—Starting from the assumption that two molecules of a gas impinging one on the other subsequently remain associated when the relative velocity of their translatory motion does not reach a certain value dependent only on the nature of the molecules, the author derives the following equation of state: $(p + ae^{b/T}/v^2T^{1/2})(v - b) = RT$, where a and b are constants. This equation, which is of the type of Clausius' equation, gives at constant volume values of the function, $\pi = T\,.\,\partial p/\partial T - p$, in satisfactory agreement with the recent determinations of Leduc, the product πT diminishing at first and becoming sensibly constant only at temperatures above the critical temperature. T. H. P.

291. *Vapour Pressure of Concentrated Aqueous Solutions.* **E. P. Perman** and **T. W. Price.** (Faraday Soc., Trans. 8. pp. 69–81; Discussion, pp. 82–85, Oct., 1912.)—(1) Measurements have been made of the vapour-pressures of solutions of urea, glycerol, cane-sugar, potassium chloride, calcium chloride, and raffinose over a very wide range of concentrations, and at different temperatures. (2) The lowering of the vapour-pressure has been found to be proportional to the concentration, except for very high concentrations. (3) Babo's law has been found to hold in some cases. (4) Hydration, when present, is not fixed, but is a function of the concentration. L. H. W.

292. *Fractionation by Diffusion; Application to Colloidal Solutions. Part I.* **S. Dabrowski.** (Acad. Sci. Cracovie, Bull. 6a. pp. 485–526,

June, 1912).—A new diffusion-apparatus has been devised in which diffusion takes place under constant conditions and in the absence of convection-currents. In the case of solutions of urea of different concentrations the product of the coefficient *h* multiplied by the viscosity η of the liquid is constant at a given temperature; Einstein's formula may therefore be used for interpolation. The values of the diffusion-coefficient are, however, lower than those determined in the ordinary way by the method of "free diffusion." The coefficient of diffusion of crystallised ovalbumen, diffusing in solutions of ammonium sulphate, is lower than that of the dialysed albumen dissolved in pure water. By means of Einstein's formula it is possible to calculate the volumes of the molecules from the diffusion-coefficient and the viscosity; the molecular volume of ovalbumen in 8·6% ammonium sulphate was thus shown to be six times less than in the absence of salts. T. M. L.

293. *The Mutual Association of Ether and Chloroform in the Gaseous State.* **F. Dolezalek** and **A. Schulze.** (Deutsch. Phys. Gesell., Verh. 14. 24. pp. 1091–1096, Dec. 30, 1912.)—It has previously been shown [see Abstract No. 781 (1912)] that in the case of mixtures of ether and chloroform in the liquid state the deviations which are met with from the law of mixtures can be explained by assuming the formation of a partially dissociated compound of the two substances. The authors have investigated the behaviour of the substances in the gas state, in order to see whether any evidence was to be found of a similar association. The method which they employed was to find out whether there was any change of volume when the unsaturated vapours were mixed. When the vapours were mixed it was found that contraction occurred, pointing to the fact that combination occurred even in the gaseous state. Moreover, from the amount of contraction the authors calculated that in a molecular mixture of ether and chloroform at 80° and under a pressure of 1 atmo. compound-formation occurs to the extent of 0·64 molecule per cent. Further, by the application of the law of mass action it follows that the combination between ether and chloroform increases almost proportionally with the total pressure: so that in the saturated vapours, at 80°, combination takes place to the extent of 1·4 molecules per cent. It follows therefore that in the liquid state compound-formation also occurs, and it is calculated that the liquid phase contains 14·6 molecules per cent. of the compound. A. F.

294. *Dissociation of Some Oxides, Carbonates, and Sulphides.* **W. Hempel** and **C. Schubert.** (Zeitschr. Elektrochem. 18. p. 729, Aug. 15, 1912. C. Schubert's Dissertation, Techn. Hochschule, Dresden.)—A table of observations made by determining the volume of gas generated in an electric furnace at temperatures measured by a le Chatelier pyrometer. The table gives the temperatures of the beginning and the end of the dissociations for some ores (manganese dioxide, hematite, spathic iron ore, pyrites of iron and copper, magnesite, etc.), and some compounds (PbO_2, permanganate, nitrates, chromates). H. B.

295. *The Potential of Tantalum.* **G. v. Hevesy** and **R. E. Slade.** (Zeitschr. Elektrochem. 18. pp. 1001–1002, Nov. 15, 1912.)—Owing to the instability of the aqueous solutions of their salts, the potentials of tantalum, vanadium, etc., are still uncertain. W. v. Bolton [Abstract No. 1098 (1905)] placed tantalum between Pt and Ag. The authors experiment with the metal and its pentafluoride TaF_5, polarising the metal both anodically and kathodically to overcome the passivity difficulty. In the passive state the potential is about 1 volt higher than that of silver, in the active state nearly the same as that of copper. H. B.

296. *Combustion Galvanic Cells.* **E. Baur** and **H. Ehrenberg.** (Zeitschr. Elektrochem. 18. pp. 1002–1011, Nov. 15, 1912. H. Ehrenberg's Dissertation, Zürich.)—The cells consist of U-tubes of porcelain, heated to 1000° by a coil. The lower portion contains fused silver; a nickel wire dips into the one limb; the other contains over the silver the electrolyte, generally within a short tube of porcelain to protect the walls of the U. Into the electrolyte dips the other electrode, a carbon rod, or tubes of Pt, Fe, Ni, Cu; hydrogen or CO is introduced into this limb, oxygen is blown into the other. The electrolytes are carbonates and metasilicates of K and Na in mixtures, cryolite and alumina, and chiefly borax; sodium metaphosphate did not answer for some obscure reason. The other electrolytes resembled one another in their behaviour and yielded about 1 volt against the Ag-O electrode. In larger-scale experiments the silver was melted in a porcelain crucible and oxygen blown into it; a magnesia crucible above the silver contained the electrolyte and carbon tubes, the whole being heated within a tubular furnace. These cells had internal resistances of less than ½ ohm, gave nearly 1 volt on open circuit and were free from polarisation after working for several hours at comparatively large current outputs. Several of the other combinations also yielded nearly the theoretical volts. H. B.

297. *Silver Nitrate-Acetone Concentration Cell.* **A. Roshdestwensky** and **W. C. McC. Lewis.** (Chem. Soc., Journ. 101. pp. 2094–2099, Nov., 1912.)—The experiments mentioned in Abstract No. 417 (1912) are continued with a very sensitive Lipmann capillary electrometer, the concentration cells containing silver nitrate in acetone. When the nitrate is exposed to sunlight for a day, a brown precipitate is formed, but the e.m.f. is not measurably affected. Nernst's formulæ being found applicable, the transport number of the anion of silver nitrate in acetone at 19° would range from 0·60 to 0·56 for concentrations ranging from 0·02-N to 0·007-N and less. The liquid/liquid potential can no more accurately be eliminated by the interposition of ammonium acetate, than it could in the previous experiments by lithium nitrate; the validity of middle-liquid methods for acetone solution appears doubtful. H. B.

298. *Temperature-variation of the Conductivity of Aluminium Anode-films.* **G. E. Bairsto.** (Faraday Soc., Trans. 8. pp. 232–251; Discussion, p. 252, Oct., 1912.)—The law previously found by the author [Abstract No. 619 (1912)], that the leakage currents of Al anode-films vary with temperature according to $i = A\epsilon^{\alpha\theta}$, is confirmed for many electrolytes (ammonium borate, phosphate, dicarbonate, molybdate, acetate), and seems to have a general meaning. The α is independent of the formation voltage, the time of formation, the concentration of the electrolyte and the kathion; it depends only on the anion being a definite function of the equivalent weight of the anion in solution, and may serve for determining this quantity. For a given formation voltage, α decreases with the voltage of the test; but when a certain current density is reached (the same for all test voltages), the conductivity increases more rapidly than according to the formula. The A varies widely with the different factors. For voltages up to about half the formation voltage the resistance of the film is practically constant; then it falls off rapidly. The ammonium dicarbonate forms an exception because it is decomposed at 58° C.; this shows already at 55°. H. B.

299. *Electrolysis in Liquefied Sulphur Dioxide.* **L. S. Bagster** and **B. D. Steele.** (Faraday Soc., Trans. 8. pp. 51–67, Oct., 1912. Chem. News, 105. pp. 157–160, April 4, 1912. Elektrochem. Zeitschr. 19. pp. 241–246, Dec., 1912.)—During the electrolysis of solutions of potassium iodide, sodium iodide, tetramethylammonium iodide and trimethylsulphonium iodide in anhydrous, liquid sulphur dioxide, sulphur is deposited at the kathode, a sulphite being formed at the same time. At the anode, changes occur which are analogous to those occurring in aqueous solution; for example, bromine and iodine are liberated from solutions of bromides and iodides. Anodes of zinc and iron are attacked and pass into solution as complex iodides when iodides are electrolysed. Investigation of a solution of both hydrogen bromide and water in liquid SO_2 showed that water is carried to the kathode during electrolysis, which is evidence in favour of the formation of an oxonium compound between the water and the hydrogen bromide, which is electrolytic in character. This evidence was strengthened by comparison with the behaviour of several well-known oxonium compounds, for example, dimethylpyrone. A few electrode potentials of metals (Pb, Zn, and Cd) immersed in a saturated solution of their salts (chloride, bromide, and iodide) were measured at − 35° and found to give remarkably constant values, as follows:—

$$\mathrm{Pb} \mid \mathrm{PbCl_2} \mid \mathrm{Hg_2Cl_2} \mid \mathrm{Hg} = 0{\cdot}435 \text{ volt};$$
$$\mathrm{Zn} \mid \mathrm{ZnBr_2} \mid \mathrm{Hg_2Cl_2} \mid \mathrm{Hg} = 0{\cdot}37\text{—}0{\cdot}40 \text{ volt};$$
$$\mathrm{Cd} \mid \mathrm{CdI_2} \mid \mathrm{Hg_2Cl_2} \mid \mathrm{Hg} = 0{\cdot}42\text{—}0{\cdot}445 \text{ volt}.$$

The mercury electrode is negative in the first two cases. Owing to the extremely small capacity of the cells it was necessary to use a quadrant electrometer in making the measurements. T. S. P.

300. *The Lead Sulphide Electrode and the Passivity of Lead.* **P. P. Lebedew.** (Zeitschr. Elektrochem. 18. pp. 891–896, Oct. 15, 1912.)—The original measurements of Bernfeld on the lead sulphide electrode [see Abstract No. 540 (1898)] having given values which are in total disagreement with the known solubility of lead sulphide, the author has repeated them, using exactly the same method as Bernfeld. His results are in very good agreement with those of Bernfeld. The disagreement mentioned above is due to the fact that the lead-sulphide electrode is not really a reversible one of the second kind. Exactly the same values for the e.m.f. are obtained when a Pt electrode replaces the lead in a solution of sodium hydrosulphide, that is, when there is no lead in the cell. Lead sulphide is thus to be considered as an indifferent electrode in this solution, that is, lead behaves as a passive metal in solutions of sodium hydrosulphide. The fact remains, however, that a Pb or Pt electrode has a perfectly definite potential in solutions of sodium hydrosulphide saturated with hydrogen sulphide, although further experiments are necessary to determine what the electrode process is. T. S. P.

301. *Iodine Coulombmeter and the Value of the Faraday.* **E. W. Washburn** and **S. J. Bates.** (Amer. Chem. Soc., Journ. 34. pp. 1341–1368, Oct., 1912. Paper read before the 8th Internat. Congress of Applied Chemistry, Sept., 1912.)—A review of the work which has hitherto been done on the

silver, copper, iodine, and oxyhydrogen coulombmeters indicates that the silver coulombmeter gives too low a value for the faraday, but is superior to all the other types in reproducibility. The authors have endeavoured to obtain an iodine coulombmeter which should equal the silver coulombmeter in reproducibility, and be free from all sources of error amounting to more than 0·001 %. The apparatus devised consists essentially of two vertical limbs connected by a V-tube, and furnished with electrodes of Pt-Ir foil. It is filled with 10 % potassium iodide solution to a little above the level of the V-tube, and then a concentrated solution of potassium iodide is layered beneath the solution in the anode limb, whilst a solution of iodine in potassium iodide is similarly layered in the kathode limb. A comparison of the amount of iodine liberated at the anode with the amount which disappears at the kathode shows that within the limits of error in analysis the same quantity of iodine is formed from iodide ions at the anode as is converted into iodide ions at the kathode. The coulombmeter is free from any constant source of error amounting to more than 0·002 %, and the reproducibility of the reaction at the anode fulfils the requirements necessary for a trustworthy determination of the faraday within 0·005 %. The iodine coulombmeter was then compared with the silver coulombmeter and applied to the determination of the faraday, the mean value of which was found to be 96,524 coulombs per equivalent ($I = 126{\cdot}92$), the electrochemical equivalent of iodine being 1·31491 mgm. per coulomb. If the ratio of Ag to I as found by Baxter is employed instead of the international atomic weights, the results give 1·11755 for the electrochemical equivalent of silver. [*Errata*, ibid. p. 1515, Nov., 1912.] T. S. P.

302. *Influence of Acid Concentration on the Chemical Polarisation of the Reversible Electrode Cu/Cu··.* **D. Reichinstein, A. Bürger,** and **A. Zieren.** (Zeitschr. Elektrochem. 18. pp. 850–864, Oct. 1, 1912.)—The polarisation observed when a metal is anodically dissolved or kathodically deposited is not a concentration polarisation, but of chemical nature, since it may assume values of a higher order. The polarisation involves two phenomena: the primary current flow, due to the absorption or liberation of electrons, is practically instantaneous; the secondary process is subject to chemical inertia (Haber). The concentration of the free acid in the electrolyte exerts an influence [see Abstract No. 1629 (1911)]. The authors deduce from the general equation for the polarisation a relation between current density and the concentration which determines the polarisation. The quantitative experiments demonstrate that, for the reversible electrode $Cu/CuSO_4$, both the kathodic and the anodic polarisation diminish with increasing acid concentration; the acid concentration was varied between 0·0188-N and 2·188-N. The same rule holds for the kathodic polarisation of $Cd/CdSO_4$. The quotient of current density J and acid concentration ($c = x$): $J/x = y$, can be expressed as a hyperbolic function $y - a = b/x$, the constants of which have been determined by the method of mean squares. On the other hand J is $= ac + b$, which is a linear relation, but the straight line does not pass through the origin of the co-ordinates. The current density is hence greater than zero when the acid concentration is zero. The phenomena seem to depend upon two quantities, only one of which is dependent upon the acid concentration; this is explained by reference to chemical kinetics, and an expression is found for the asymptotic value of the polarisation which is independent of time. H. B.

303. *Passivity of Iron under Boiler Conditions.* **H. G. Byers** and **F. T. Voris.** (Amer. Chem. Soc., Journ. 34, pp. 1368–1379, Oct., 1912.) [See

Abstract No. 2065 (1908).]—The suggestion has been made by Cushman that small quantities of inhibitive substances in boilers should be highly efficacious in preventing pitting. The authors have studied the effect of potassium dichromate, the temperatures used approaching those prevailing under steam-boiler conditions. In all cases the electrochemical method of investigation was used. It is found that an iron anode is rendered passive by dichromate solutions of concentration as low as 0·125 per cent., and is kept passive, even when the anodic current is very small, at all temperatures ranging from room temperature to those approximating boiler conditions (160°). In the presence of moderate quantities of sodium chloride the concentration of dichromate required to maintain the passive state is approximately 40 times greater at room temperature; 25 times greater at 93°, and 40 times greater at 125°–150°. The authors can offer no explanation of this peculiar behaviour. When sodium sulphate is present in moderate concentrations, an equal concentration of dichromate is sufficient to ensure passivity of the anode at temperatures up to 150°. The presence of carbonates and bicarbonates in water seems to have no destructive effect on passivity induced by dichromate. From these results it seems probable that since the percentage of chlorides in boiler water is usually small, the addition of an amount of dichromate 40 times that of the chlorides present, calculated as sodium chloride, plus that needed to precipitate the scale-forming substances, would be of much value as a boiler preservative. The doubtful factor in the above experiments is, however, the extent to which the results have been influenced by the anodic current. Experiments are therefore being carried out to ascertain how long iron will remain unrusted in such inhibitive solutions in the absence of the electric current. T. S. P.

304. *Electrolytic Formation of Dichromate from Chromate.* **E. Müller** and **E. Sauer.** (Zeitschr. Elektrochem. 18. pp. 844–847, Oct. 1, 1912.)—The electrolysis of sodium chromate yields more dichromate than alkali in diaphragm cells. The authors use iron as kathode in sodium hydrate and a Pt cylinder as anode in sodium chromate contained in a clay cylinder. The reason of the anomaly is that within the pores of the diaphragm the lye becomes three times as concentrated in free alkali as in the much larger space near the kathode, and this should always take place, when the kathode stands in alkali and the anode in a neutral salt. H. B.

305. *Electrolytic Method for the Prevention of the Corrosion of Iron and Steel.* **J. K. Clement** and **L. V. Walker.** (Electrician, 70. p. 132, Nov. 1, 1912. Paper read before the Internat. Congress of Applied Chemistry, 1912.)—The authors have investigated the influence of (*a*) rate of stirring the electrolyte, (*b*) amount of oxygen in the electrolyte, and (*c*) acid concentration, on the corrosion of steel. A counter e.m.f., depending upon these factors, can prevent corrosion and the current density required can be calculated from the loss of weight of the metal under the given conditions when not protected and the electrochemical equivalent. F. C. A. H. L.

306. *The Law of Molecular Attraction.* **J. E. Mills.** (Phil. Mag. 24. pp. 483–500, Oct., 1912.)—The author discusses *seriatim* some of the divergences found, and shows that these were not due to the inaccuracy of his equation. L. H. W.

307. *Constitution and Melting-points of Copper-slags.* **C. H. Fulton.** (Amer. Inst. Mining Engin., Bull. 72. pp. 1457–1486, Dec., 1912.)—Gives freezing- and melting-curves and tables of composition and melting-point; also full details of the thermoelectric method employed. L. H. W.

308. *Fundamental Properties of the Equation of State.* **R. D. Kleeman.** (Phil. Mag. 24. pp. 391–401, Sept., 1912.)

309. *Extension of the Theory of Allotropy, Monotropy, and Enantiotropy for Liquids.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 861–871, Oct. 24, 1912.) [See Abstract No. 1279 (1912).]

310. *Contribution to the Theory of the Binary Systems.* XXI. *Condition for the Existence of Minimum Critical Temperature.* **J. D. van der Waals.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 602–614, Nov. 28, 1912.)

311. *Calculation of the Thermodynamic Potential of Mixtures, when a Combination can take place between the Components.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 614–620, Nov. 28, 1912.)

312. *Solubility and Supersolubility from the Osmotic Standpoint.* **Berkeley.** (Phil. Mag. 24. pp. 254–268, Aug., 1912.)—Mainly a theoretical discussion from the thermodynamic standpoint. L. H. W.

313. *The Knowledge of Liquid Mixtures.* I. **R. B. Denison.** (Faraday Soc., Trans. 8. pp. 20–47; Discussion, pp. 47–50, Oct., 1912.)—Unsuitable for brief abstraction. The author attempts to devise a more definite way of deciding upon possible association between mixed liquids. L. H. W.

314. *Elimination of Potential due to Liquid Contact.* II. **A. C. Cumming.** (Faraday Soc., Trans. 8. pp. 86–93, Oct., 1912.)—A continuation of the work dealt with in Abstract No. 543 (1907) the present paper being concerned with the equation for calculation of diffusion potential.